AD NUMBER

AD803760

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited.

FROM:

**Distribution authorized to U.S. Gov't. agencies and their contractors;
Administrative/Operational Use; 21 NOV 1966.
Other requests shall be referred to Air Force Technical Applications Center, Washington, DC.**

AUTHORITY

AFTAC ltr 28 Feb 1972

LONG RANGE SEISMIC MEASUREMENTS

HALF BEAK

3 JUNE 1966

Prepared for

AIR FORCE TECHNICAL APPLICATIONS CENTER

Washington, D. C.

21 NOVEMBER 1966

By

EARTH SCIENCES DIVISION
TELEDYNE INDUSTRIES, INC.

Under

Project VELA UNIFORM

Sponsored By

ADVANCED RESEARCH PROJECTS AGENCY

Nuclear Test Detection Office

ARPA Order No. 624

LONG RANGE SEISMIC MEASUREMENTS

HALF BEAK

30 June 1966

SEISMIC DATA LABORATORY REPORT NO. 171

AFTAC Project No.:	VELA T/6702
Project Title:	Seismic Data Laboratory
ARPA Order No.:	624
ARPA Program Code No.:	5810
Name of Contractor:	EARTH SCIENCES DIVISION TELEDYNE INDUSTRIES, INC.
Contract No.:	AF 33(657)-15919
Date of Contract:	18 February 1966
Amount of Contract:	$ 1,842,884
Contract Expiration Date:	17 February 1967
Project Manager:	William C. Dean (703) 836-7644

P. O. Box 334, Alexandria, Virginia

AVAILABILITY

This document is subject to special export controls and each transmittal to foreign governments or foreign national may be made only with prior approval of Chief, AFTAC.

This research was supported by the Advanced Research Projects Agency, Nuclear Test Detection Office, under Project VELA-UNIFORM and accomplished under the technical direction of the Air Force Technical Applications Center under Contract AF 33(657)-15919 .

Neither the Advanced Research Projects Agency nor the Air Force Technical Applications Center will be responsible for information contained herein which may have been supplied by other organizations or contractors, and this document is subject to later revision as may be necessary.

TABLE OF CONTENTS

BLANK PAGE

HALF BEAK

EVENT DESCRIPTION

DATE: 30 June 1966

TIME OF ORIGIN: 22:15:00.1Z

YIELD:

MAGNITUDE: 6.02 ± 0.60

LOCATION:

SITE: Nevada Test Site, Area U19b

GEOGRAPHIC COORDINATES:

Lat: 37°18'57.0" N

Long: 116°17'56.0" W

ENVIRONMENT:

GEOLOGIC MEDIUM: Rhyolite

SURFACE ELEVATION: 6791 ft.

SHOT ELEVATION: 3907 ft.

SHOT DEPTH: 2884 ft.

COMPUTED EPICENTER: ALL STATIONS

GEOGRAPHIC COORDINATES:

Lat: 37°13'12.0" N

Long: 116°24'36.0" W

TIME OF ORIGIN: 22:15:04.9Z

DEPTH: 52.6 km

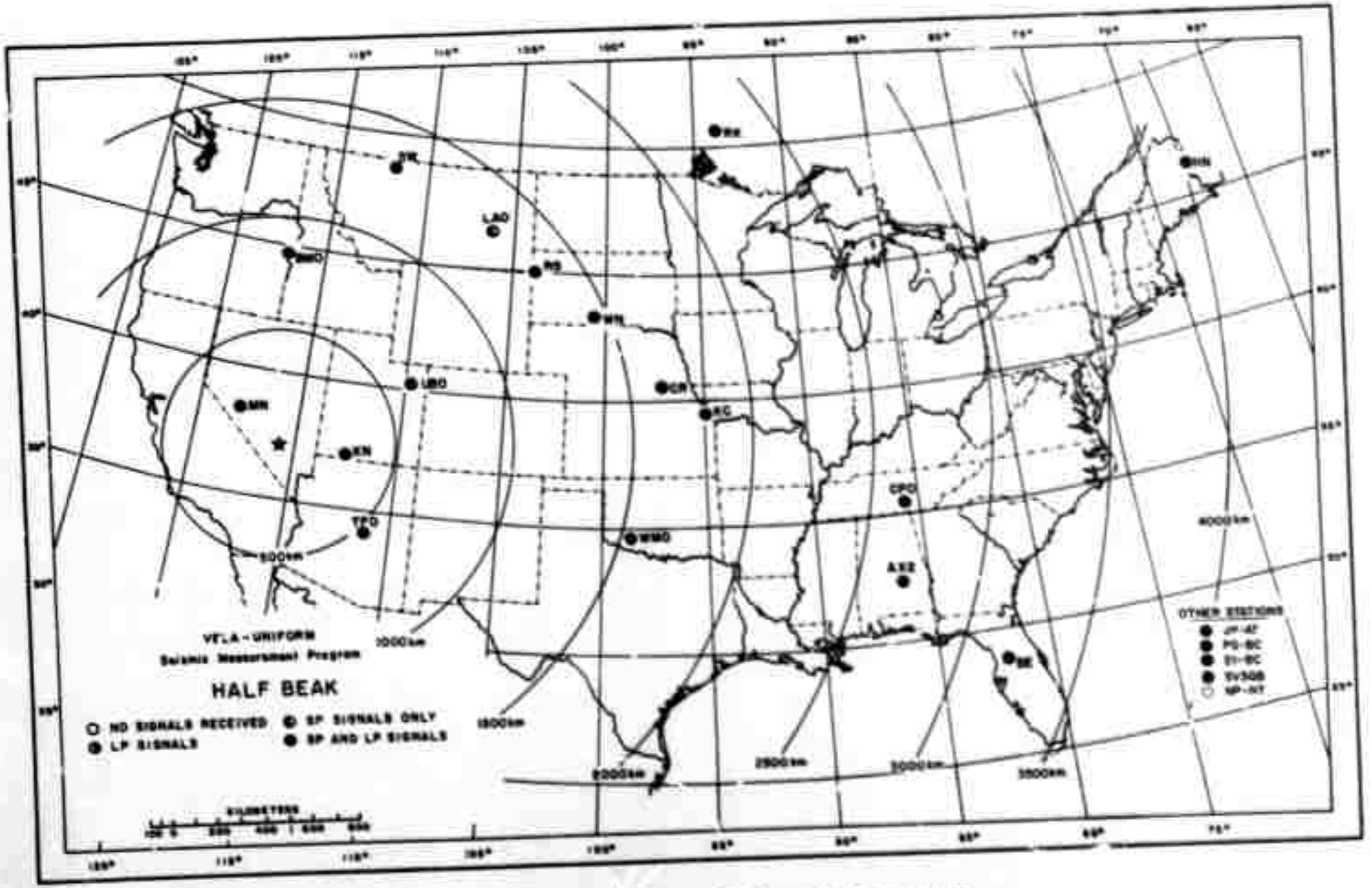
EPICENTER SHIFT: 14.4 km, S 43° W

Code	Station	Final							
		SPZ	SPR	SPT	LPZ	LPR	LPT	Tape	Timing
MN-NV	Mina, Nevada	•	•	•	•	•	•	•	P
KN-UT	Kanab, Utah	•	•	•	•	•	•	•	S
TFSO-Z1	Tonto Forest Observatory, Arizona	•	•	•	•	•	•	•	P
UBSO-Z10	Uinta Basin Observatory, Utah	•	•	•	•	•	•	•	P
BMSO-Z2	Blue Mountain Observatory, Oregon	•	•	•	•	-	•	•	P
LAO	Suberray AO-10, Montana	•	M	M	M	M	M		P
SW-MA	Sweetgrass, Montana	•	•	•	•	•	•	•	P
RG-SD	Redig, South Dakota	•	•	•	•	•	•	•	P
WN-SD	Winner, South Dakota	•	•	•	•	•	•	•	P
WMSO-Z6	Wichita Mountain Observatory, Oklahoma	•	•	•	•	-	•	•	P
CR-NB	Crete, Nebraska	•	•	•	•	•	•	•	P
JP-AT	Jasper, Alberta, Canada	•	•	•	•	•	•	•	P
KC-MO	Kansas City, Missouri	•	•	•	•	•	•	•	P
PG-BC	Prince George, British Columbia, Canada	•	•	•	•	•	•	•	P
SI-BC	Smithers, British Columbia, Canada	•	•	•	•	•	•	•	P
RK-ON	Red Lake, Ontario, Canada	•	•	•	•	•	•	•	P
CPSO-Z8	Cumberland Plateau Observatory, Tennessee	•	•	•	•	•	•	•	P
AM2AL	Alexander City, Alabama	•	•	•	•	•	•	•	P
BE-FL	Belleview, Florida	•	•	•	•	•	•	•	P
MN-ME	Moulton, Maine	•	•	•	•	•	•	•	P
SVJC	Schefferville, Quebec, Canada	•	•	•	•	•	I	•	P
MP-NT	Mould Bay, Northwest Territories, Canada	I	I	I	I	I	I	•	P

I Inoperative
M No Instrument
P Primary Timing
S Secondary Timing
• Signal
- No Signal

Station Status Report - HALF BEAK

Table 1



Recording Stations and Signals Received

Figure 1

INTRODUCTION

A long range seismic measurements (LRSM) program and several larger seismographic observatories were established under VELA-UNIFORM to record seismological data resulting from natural seismic activity and a planned series of U. S. underground nuclear tests. The LRSM teams are mobile and occupy locations selected to provide optimum data from events of special interest; the observatories are permanent installations as follows:

Wichita Mountains Seismological Observatory (WMSO)
Lawton, Oklahoma

Uinta Basin Seismological Observatory (UBSO)
Vernal, Utah

Blue Mountain Seismological Observatory (BMSO)
Baker, Oregon

Cumberland Plateau Seismological Observatory (CPSO)
McMinnville, Tennessee

Tonto Forest Seismological Observatory (TFSO)
Payson, Arizona

Large Aperture Seismic Array (LASA)
Billings, Montana

The purpose of this report is to provide an analysis

of data resulting from the HALF BEAK event recorded by the LRSM teams and the VELA observatories and a preliminary summary of data reported by other permanent and temporary seismographic stations.

INSTRUMENTATION AND PROCEDURE

The instrumentation at each of the LRSM locations consists of three-component short-period and three-component long-period seismographs. In general, data are recorded on 35 millimeter film and on one-inch 14 channel magnetic tape although recently more portable instrumentation has been incorporated which records only on magnetic tape. The stations are all equipped to record WWV continuously to provide accurate time control and calibration is accomplished once each day and just prior to each shot at the operational settings. Pertinent information useful for analysis of LRSM data is available to qualified users of this data and is contained in Technical Report 65-43, "Interpretation and Usage of Seismic Data, LRSM program." General information on LRSM van and portable system equipment and operation is given in Technical Reports 66-27, "The LRSM Mobile Seismological Laboratory," and 65-74, "A Portable Seismograph." Copies of

these reports may be obtained from DDC. The AD control number of Technical Report 66-27 is 480343. All the observatories have both long-period and short-period, three-component instrumentation, in addition to their other specialized facilities.

Station information is presented in Appendix I. This includes the station name and code; the geographic coordinates, distances and azimuths involved; the station elevations; and the type of instruments in use at each location. Representative instrumental response curves are shown in Appendix II(B).

The procedures used in measuring amplitudes reported herein is illustrated in Appendix II(A) and the unified magnitude is calculated as shown in Appendix I(B). The distance factors (B) beyond 16° are from Gutenberg and Richter*. For distances less than 16° values were read from a curve in the Gutenberg and Richter paper back to 10° and then extrapolated to 2°, using an inverse cube relationship.

A standard hypocenter location program for a digital

*Gutenberg, B. and Richter, C. F., Magnitude and Energy of Earthquakes, Ann. Geofis., 9 (1956), pp. 1-15

computer is used to determine the location using data from all stations analyzed. Best-fit values of latitude, longitude, depth of focus, and time of origin are determined statistically by a least squares technique. This utilizes a Jeffreys-Bullen travel-time curve as modified by Herrin in 1961 on the basis of Pacific surface-focus recordings. Precision of the computation is limited primarily by the accuracy of arrival times, the validity of the standard travel-time curve, and by local velocity deviations. Since the method is based on P-wave arrivals, this particular program does not make use of later phases such as pP and S in the determination of depth or location.

DATA AND RESULTS (LRSM and VELA OBSERVATORIES)

The parameters of the HALF BEAK event and a summary of the seismic evaluation is shown on the Event Description page. The operational status of the 22 LRSM stations and observatories is given in Table 1 and illustrated in Figure 1.

Table 2 summarizes the measurements made of the principal phases from the HALF BEAK event at the LRSM and VELA stations. Included are the Pn and P arrival times, the maximum amplitudes (A/T) of Pn or P motion and other phases

as seen on the short-period vertical instruments. Long-period Love and Rayleigh wave motion are also tabulated in (A/T) form. In addition, individual station Rayleigh wave areas (mm^2) is indicated as measured on the LPZ only. Although reduced to 1K magnification, they have not been normalized to any magnitude. Twenty-one stations recorded short-period signals. Long-period signals from this event were recorded by 20 stations.

The unified magnitudes determined from the LRSM and VELA observatories is shown in Figure 2. The average magnitude is 6.02 ± 0.60 .

The travel-time residuals from the Pn and P phases are shown in Figure 3. Figures 4 through 8 illustrate plots of the amplitude of P, Pg, Lg, LQ, and LR.

Attached to the report are illustrative seismograms showing the signals recorded at 4 stations. The most distant station analyzed that recorded HALF BEAK was SV3QB at a distance of 4187 kilometers.

Principal Phases
HALF BEAK
30 June 1966
22:15:00.1Z

Code	Station	Distance	Inst.	Magnification (k) Film x 10	Phase	Observed Travel Time (min)	Observed Travel Time (sec)	Period T (sec)	Maximum Amplitude A/T	Magnitude (m)	Area (mm^2) LPZ
NN-NV	Nina, Nevada	205	SPZ	0.32	Pn	0	12.7	0.5	13575		
			ZPZ	0.11*	Pg	0	34.1	0.65	105741		
			SPT	0.15	Lg			0.7	51450		
			LPT		LQ			---	---		
			LPZ		LZ			---	---		
KN-UT	Kaneb, Utah	110	SPZ	0.294	Pn	0	44.2	0.4	10369	6.62	
			ZPZ	0.294	Pg	0	52.6	0.6	27878		
			SPT	0.295	Lg			0.9	24212		
			LPT	1.12	LQ			12.0	1828		
			LPZ	1.02	LR			12.0	9250		1609.76
TEBO	Tonto Forest Observatory, Arizona	565	SPZ-1	5.0	Pn	1	19.1	0.65	525	4.16	
			ZPZ-1	5.0	e	1	21.9	0.45	698		
			SPZ-1	5.0	e	1	26.1	0.7	360		
			ZPZ-1	5.0	e	1	26.6	0.4	658		
			ZPR-1	0.8	Pg	1	33.4	0.7	2997		
			ZPN	0.8	Lg			1.3	3744		
			SPN	0.8	Lg			1.1	2226		
			LPZ		LQ			---	---		
			LPZ		LQ			---	---		
			LPZ	(0.3)	LR			16.0	(7194)		6483.33
UBSO	Uinta Basin Observatory, Utah	673	SPZ-10	1.0	Pn	1	(34.4)	1.15	3125	7.11	
			SPZ-10	1.0	(Pn)	1	(43.1)	1.0	1425		
			SPZ-10	1.0	Pg	1	(51.4)	0.9	5141		
			SPZ	0.97	Lg			1.2	4934		
			SPN	0.97	Lg			1.3	6013		
			LPN	9.3*	LQ			14.0	149		
			LPN	9.3*	LQ			14.0	249		
			LPZ	8.4*	LR			(14.0)	(212)		149.52
BMZO	Elus Mountain Observatory, Oregon	841	SPZ-3	17.5*	Pn	1	54.7	0.5	(58.1)	(5.47)	
			ZPZ-3	17.5*	e	2	02.3	1.15	564		
			SPZ-3	17.5*	e	2	06.9	1.0	571		
			ZPZ-3	17.5*	Pg	2	14.5	1.0	2284		
			SPZ	5.94*	Lg			1.6	2144		
			SPR	5.43*	Lg			1.45	2857		
			LPZ	0.60*	LQ			18.0	965		
			LPR		LR			---	---		
LAO	Zubarrey AO-10, Montana	1123	SPZ	28.7	Pn	2	52.5	(1.15)	(368)	(4.47)	
			SPR	28.7	Pg	3	(34.4)	1.2	(877)		
ZM-MA	Zweetgrass, Montana	1342	SPZ	33.2	P	2	54.2	1.1	646	6.90	
			SPR	33.2	e	3	03.1	0.9	240		
			SPZ	33.2	PP	3	05.6	1.1	726		
			SPZ	33.2	Pg	3	(46.7)	1.0	437		
			SPR	50.5	Lg			(1.4)	(1339)		
			SPT	39.8	Lg			1.3	647		
			LPR		LQ			---	---		
			LPT	8.15*	LQ			(16.0)	(268)		
			LPZ	2.94	LR			12.0	1937		990.51
RG-SD	Redig, South Dakota	1381	SPZ	54.1	P	2	58.5	0.8	34.0	5.59	
			SPZ	54.1	e	2	59.8	0.8	72.1		
			SPZ	54.1	e	3	01.5	0.6	109		
			SPR	40.0*	PP	3	16.2	1.3	2158		
			SPZ	40.0*	e	3	(27.3)	1.1	938		
			SPR	40.0*	(Pg)	4	05.6	1.0	456		
			SPR	45.3	Lg			1.4	928		
			SPT	54.8	Lg			1.4	515		
			LPR	7.92	LQ			12.0	532		
			LPT	4.75	LQ			12.0	252		
			LPZ	1.075	LR			12.0	2226		1418.60
WN-SD	Winner, South Dakota	1517	SPZ	43.3	P	3	15.7	1.0	341	4.27	
			ZPZ	43.3	(PP)	3	22.9	1.2	730		
			ZPZ	43.3	e	3	(49.9)	1.2	1500		
			SPZ	18.41*	Pg	4	06.4	1.0	813		
			SPR	40.0	Lg			(1.1)	(938)		
			SPT	67.2	Lg			1.2	670		
			LPR	8.72	LQ			14.0	360		
			LPT	7.45	LQ			15.0	195		
			LPZ	3.62	LR			14.0	325		713.45
MMBO	Michita Mountain Observatory, Oklahoma	1620	SPZ-6	340	P	3	(29.7)	1.35	53.5	5.10	
			SPZ-6	340	e	3	37.5	1.2	27.7		
			SPZ-6	340	Pg	4	32.7	---	---		
			LPZ	52.0	(Z)	4	25	22.0	10.9		
			LPN	51.0	(Z)	6	25.	21.0	13.6		
			ZPZ	70.0	Lg			1.5	47.6		
			SPN	70.0	Lg			(2.1)	(173)		
			LPN	27.6*	LQ			(16.0)	(195)		
			LPZ	1.9	LR			17.0	730		1089.47
CR-NE	Crete, Nebraska	1722	SPZ	26.9*	P	3	(41.2)	..0	1225	4.20	
			SPZ	24.9*	e	3	46.8	1.1	2236		
			SPZ	33.4	Pg	4	(68.9)	1.0	591		
			SPR	16.35	Lg			1.2	1581		
			ZPT	14.39	Lg			1.2	1363		
			LPR	0.61*	LQ			(16.0)	(451)		
			LPT	0.76*	LQ			17 .0	585		
			LPZ	4.1	LR			.2.0	(3242)		1208.54
JP-AT	Jasper, Alberta, Canada	1738	SPZ	69.5	P	3	43.5	1.0	82.7	6.97	
			ZPZ	69.5	e	3	45.8	1.0	227		
			SPZ	69.5	e	3	47.2	1.1	487		
			ZPZ	69.5	PP	3	(55.5)	1.2	445		
			SPZ	69.5	e	4	02.8	1.0	410		
			ZPZ	69.5	e	4	24.5	1.2	251		
			SPZ	69.5	e	4	35.7	1.2	257		
			LPR	10.8	Z	6	47	15.0	54.4		
			LPT	12.45	Z	6	47	14.0	(37.5)		
			ZPR	72.0	Lg			(2.0)	(1026)		
			SPT	68.6	Lg			(2.8)	(1177)		
			LPR	10.8	LQ			18.0	672		
			LPT	12.45	LQ			(20.0)	(216)		
			LPZ	1.86*	LZ			15.0	961		1620.41

Principal Phases
HALF BEAK
30 June 1964
22:19:00.13

Code	Station	Distance	Inst.	Magnification (k) Film x 10	Phase	Observed Travel Time (min)	Observed Travel Time (sec)	Period T (sec)	Maximum Amplitude A/T	Magnitude (m)	Area (cm^2)
KC-MO	Seneca City, Missouri	1900	SPZ	35.8*	P	4	(1.0	(1.0)	(251)	(5.30)	
			SPE	35.8*	e	4	4.7	0.8	436		
			SPE	35.8*	PP	4	(8.2	0.8	462		
			SPE	35.8*	Pg	5	(11.3)	(1.2)	(403)		
			LPR	8.3	S	7	15	11.0	75.1		
			LPT	7.1	S	7	15	12.0	53.2		
			SPR	35	Lg			(1.3)	(349)		
			SPT	37.*	Lg			1.8	813		
			LPR	0.50*	LQ			(14.0)	(1287)		
			LPT	7.1	LQ			15.0	753		904.76
			LPZ	1.26*	LR			13.0	2394		
PG-BC	Prince George, British Columbia, Canada	1914	SPE	112	P	4	03.7	1.3	339	5.43	
			SPE	31.9*	e	4	07.2	1.3	1564		
			LPE	4.64	S	7	34	10.0	453		
			LPT	10.2	S	7	34	10.0	155		
			SPR	115	Lg			2.4	447		
			SPT	113	Lg			1.7	179		
			LPE	4.64	LQ			14.0	2103		
			LPT	10.2	LQ			14.0	736		
			LPE	8.00	LR			15.0	757		1336.85
BI-BC	Smithers, British Columbia, Canada	2109	SPZ	55.1*	P	4	25.0	0.8	320	5.51	
			SPZ	55.1*	e	4	27.9	0.8	427		
			SLZ	55.1*	e	4	31.4	1.3	862		
			SPE	55.1*	e	4	(35.7)	1.0	327		
			SPE	114	e	5	02.0	1.2	276		
			SPE	114	(Pg)	5	(31.1)	1.2	305		
			SPR	122	Lg			2.3	208		
			SPT	134	Lg			2.8	404		
			LPR	0.68*	LQ			15.0	741		
			LPT	1.54*	LQ			15.0	727		
			LPE	1.42	LR			13.0	2259		1805.54
RK-ON	Red Lake, Ontario, Canada	2339	SPE	13.0*	P	4	45.2	0.9	2070	6.42	
			SPE	13.0*	e	4	47.8	0.6	1839		
			SPE	51.7	(PP)	5	04.4	1.1	323		
			SPE	51.7	e	7	24.9	1.0	42.9		
			SPE	51.7	e	7	31.7	1.2	106		
			SPT	43.8	Lg			2.1	642		
			LPT	32.3	LQ			15.0	101		
			LPE	4.92	LR			13.0	930		513.21
CPSO	Cumberland Plateau Observatory, Tennessee	2749	SPE-P	45.0	P	5	23.4	0.9	131	5.57	
			SPE-S	45.0	e	5	24.7	1.1	197		
			SPE-S	45.0	e	5	38.2	1.2	206		
			SPE-S	45.0	(Pg)	7	(31.8)	1.3	84.1		
			LPR	15.5	S	9	45	17.0	58.5		
			LPM	14.5	S	9	45	13.0	88.3		
			SPR		Lg			---	---		
			SPT		Lg			---	---		
			LPE	0.75	LQ			21.0	48.0		
			LPT	0.75	LQ			14.0	1144		
			LPE	0.50	LR			14.0	3289		1750.00
AX2AL	Alexander City, Alabama	2784	SPE	25.8*	P	5	27.4	1.1	772	6.38	
			SPE	98.4	e	5	47.3	1.1	202		
			SPE	98.4	PP	4	09.4	1.2	147		
			SPE	98.4	PcP	9	00.9	1.1	506		
			LPE	10.4	S	9	55	15.0	99.6		
			LPT	25.2	S	9	55	14.0	52.5		
			SPE	89.4	Lg			2.0	146		
			SPT	87.3	Lg			2.2	261		
			LPR	4.3*	LQ			20.0	154		
			LPT	5.0*	LQ			14.0	543		
			LPE	4.65	LR			19.0	368		1771.43
SE-FL	Belleview, Florida	3308	SPE	37.1	P	4	09.4	1.2	259	4.01	
			SPE	37.1	e	4	31.5	(1.3)	(139)		
			SPE	37.1	e	4	55.7	1.3	171		
			LPE	15.2	S	11	11	13.0	116		
			LPT	15.9	S	11	11	14.0	56.2		
			LPR	14.2	e	14	15	10.0	520		
			LPT	15.9	e	14	15	10.0	264		
			SPE	33.2	Lg			1.8	174		
			SPT	35.4	Lg			(1.8)	(142)		
			LPE	14.2	LQ			17.0	292		
			LPT	15.9	LQ			19.0	109		
			LPE	2.01	LR			16.0	1074		2109.45
NH-ME	Houlton, Maine	4073	SPE	29.0*	P	7	08.3	(1.0)	(750)	(6.41)	
			SPZ	123	e	7	17.8	0.7	47.4		
			SPE	123	e	7	20.3	0.9	70.1		
			SPE	123	PP	8	29.6	1.1	72.7		
			SPE	123	PcP	9	31.0	0.9	59.8		
			SPT	120	Lg			2.8	244		
			LPT	4.3*	LQ			(18.0)	(174)		
			LPE	4.85	LR			14.0	254		508.74
QV3QB	Schefferville, Quebec, Canada	4187	SPE	142*	P	7	14.0	1.2	315	6.00	
			SPE	142*	e	7	23.7	1.1	107		
			SPE	142*	e	7	30.8	1.1	103		
			SPZ	142*	e	7	39.5	1.1	88.7		
			SPE	142*	PP	8	39.5	1.2	208		
			SPR	136*	Lg			(1.2)	(50.4)		
			SPT	151*	Lg			(1.2)	(31.9)		
			LPR	3.88*	LQ			12.0	240		
			LPE	2.11*	LR			(16.0)	(348)		222.75

A/T mu/sec

( ) Doubtful Values or Phases

* Measurements Made From Playouts

--- Maximum Amplitude Clipped on Film & Tape

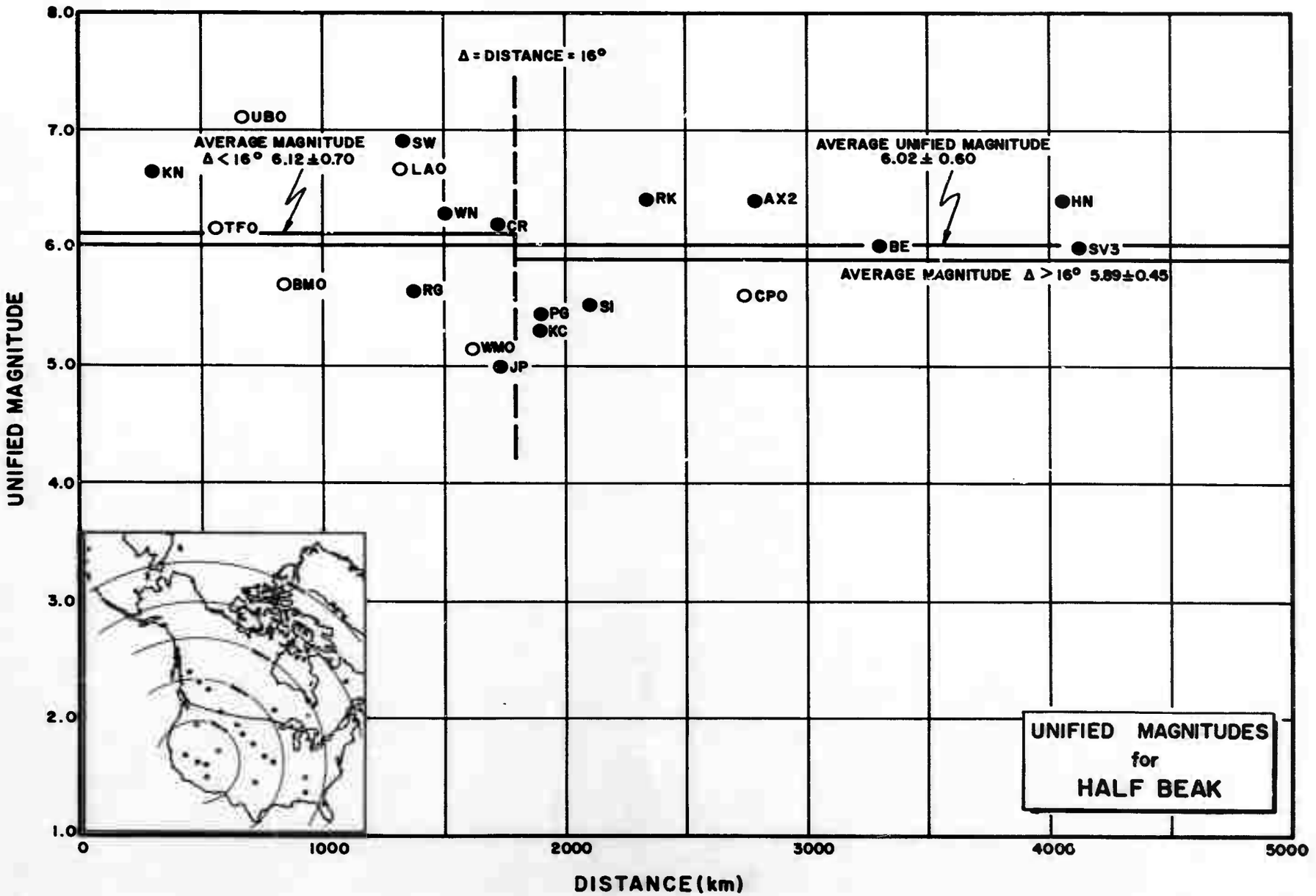

8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
UNIFIED MAGNITUDE
0
1000
2000
3000
4000
5000
DISTANCE (km)
Δ = DISTANCE = 16°
UBO
AVERAGE MAGNITUDE
Δ < 16° 6.12±0.70
SW
LAO
KN
WN
CR
TFO
BMO
RG
PG
KC
SI
WMO
JP
RK
AX2
CPO
AVERAGE UNIFIED MAGNITUDE
6.02 ± 0.60
HN
BE
SV3
AVERAGE MAGNITUDE Δ > 16° 5.89±0.45
UNIFIED MAGNITUDES
for
HALF BEAK

Figure 2

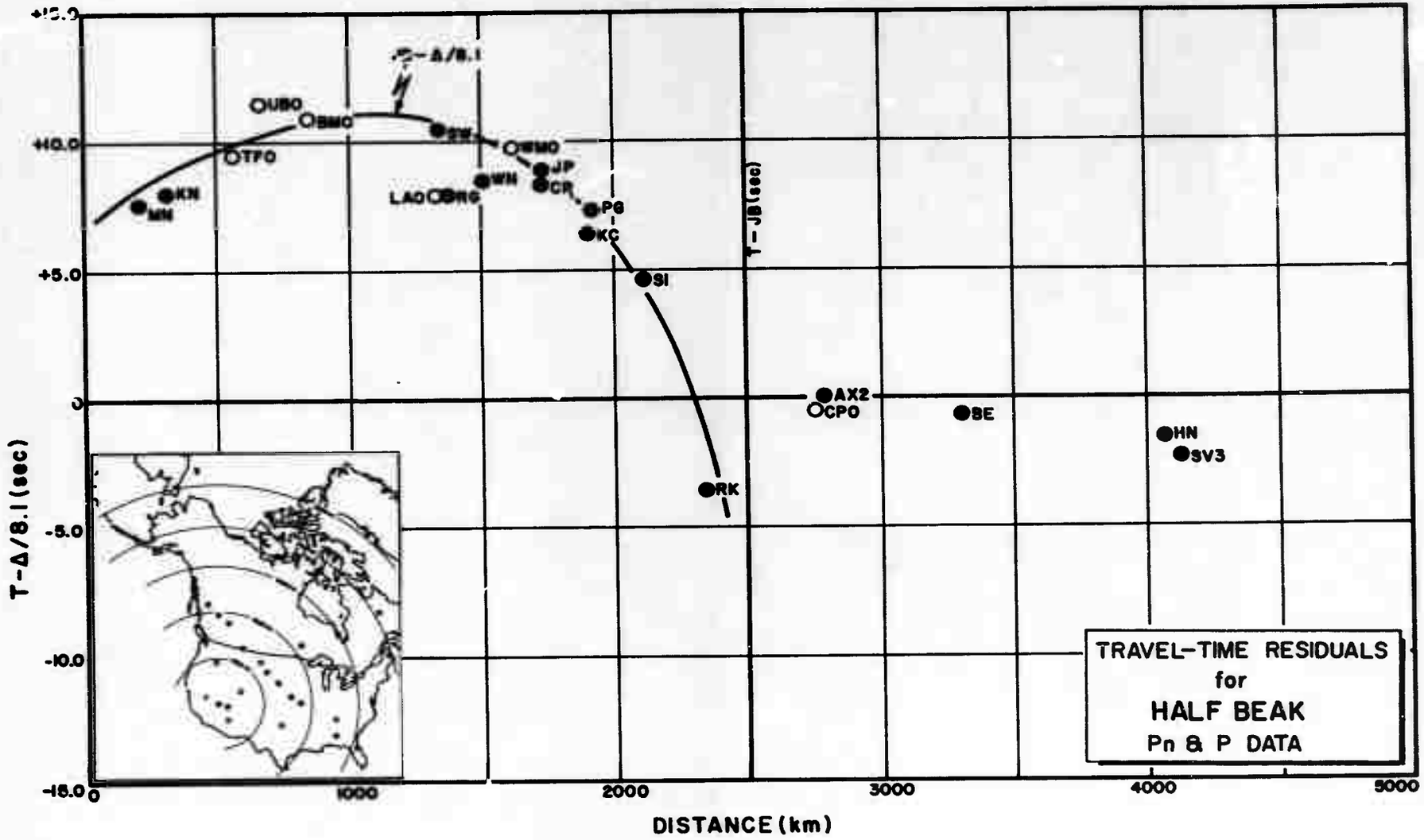

+15.0
+10.0
+5.0
0
-5.0
-10.0
-15.0
0
1000
2000
3000
4000
5000
T-Δ/8.1 (sec)
T-JB (sec)
DISTANCE (km)
Δ/8.1
UBO
BMO
TFO
KN
MN
LAO
BRG
WH
SW
BMO
JP
CP
PG
KC
SI
AX2
CPO
BE
HN
SV3
RK
TRAVEL-TIME RESIDUALS
for
HALF BEAK
Pn & P DATA

Figure 3

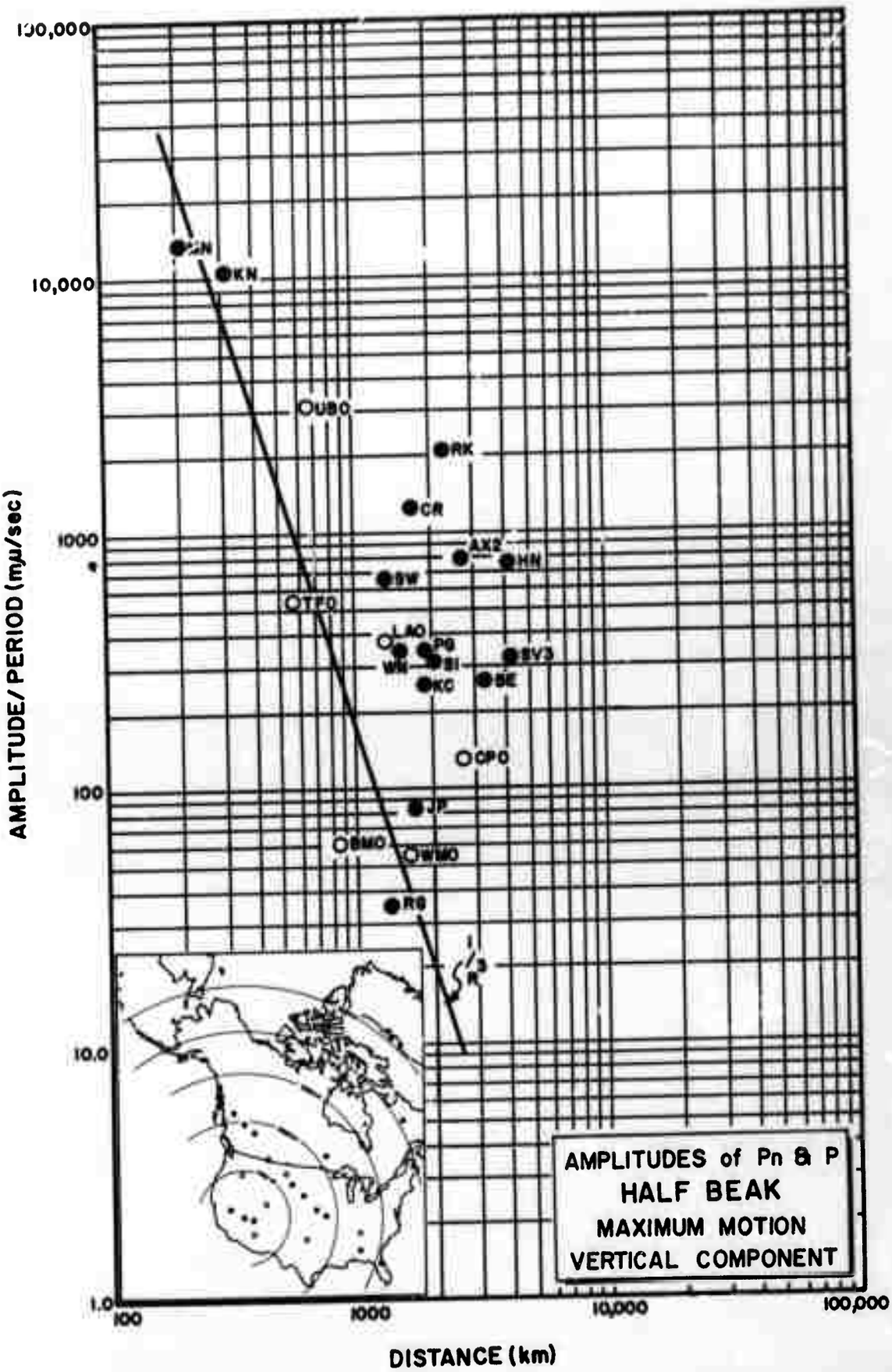

100,000
10,000
1000
100
10.0
1.0
AMPLITUDE/PERIOD (mμ/sec)
100
1000
10,000
100,000
DISTANCE (km)
KN
UBO
RK
CR
AX2
HN
SW
TFO
LAO
PG
SI
WM
KC
SE
SV3
CPO
JP
BMO
WMO
RG
R/3
AMPLITUDES of Pn & P
HALF BEAK
MAXIMUM MOTION
VERTICAL COMPONENT

Figure 4

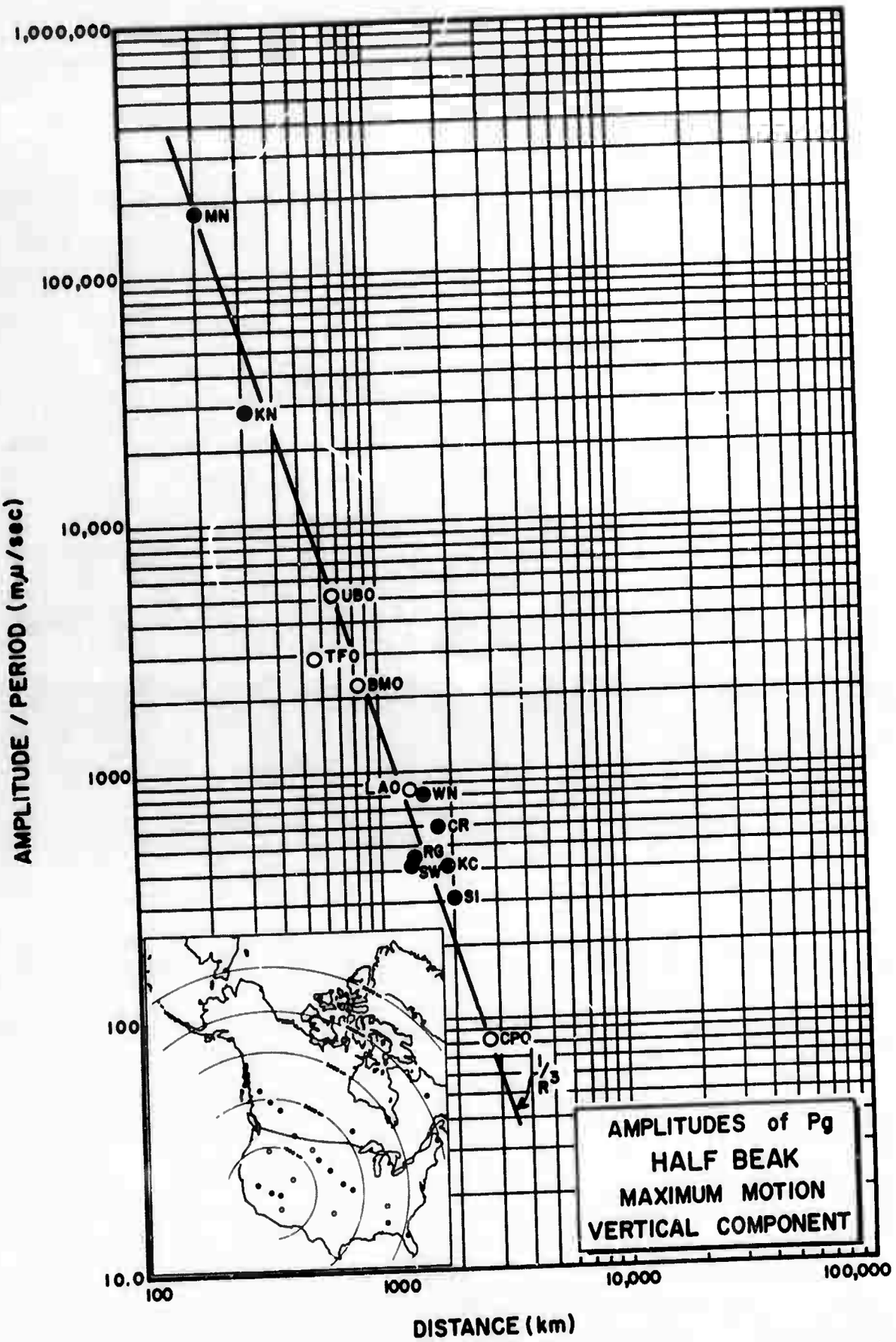

1,000,000
100,000
10,000
1000
100
10.0
AMPLITUDE / PERIOD (mμ/sec)
MN
KN
UBO
TFO
BMO
LAO
WN
CR
RG
SW
KC
SI
CPO
1/R^3
AMPLITUDES of Pg
HALF BEAK
MAXIMUM MOTION
VERTICAL COMPONENT
100
1000
10,000
100,000
DISTANCE (km)

Figure 5

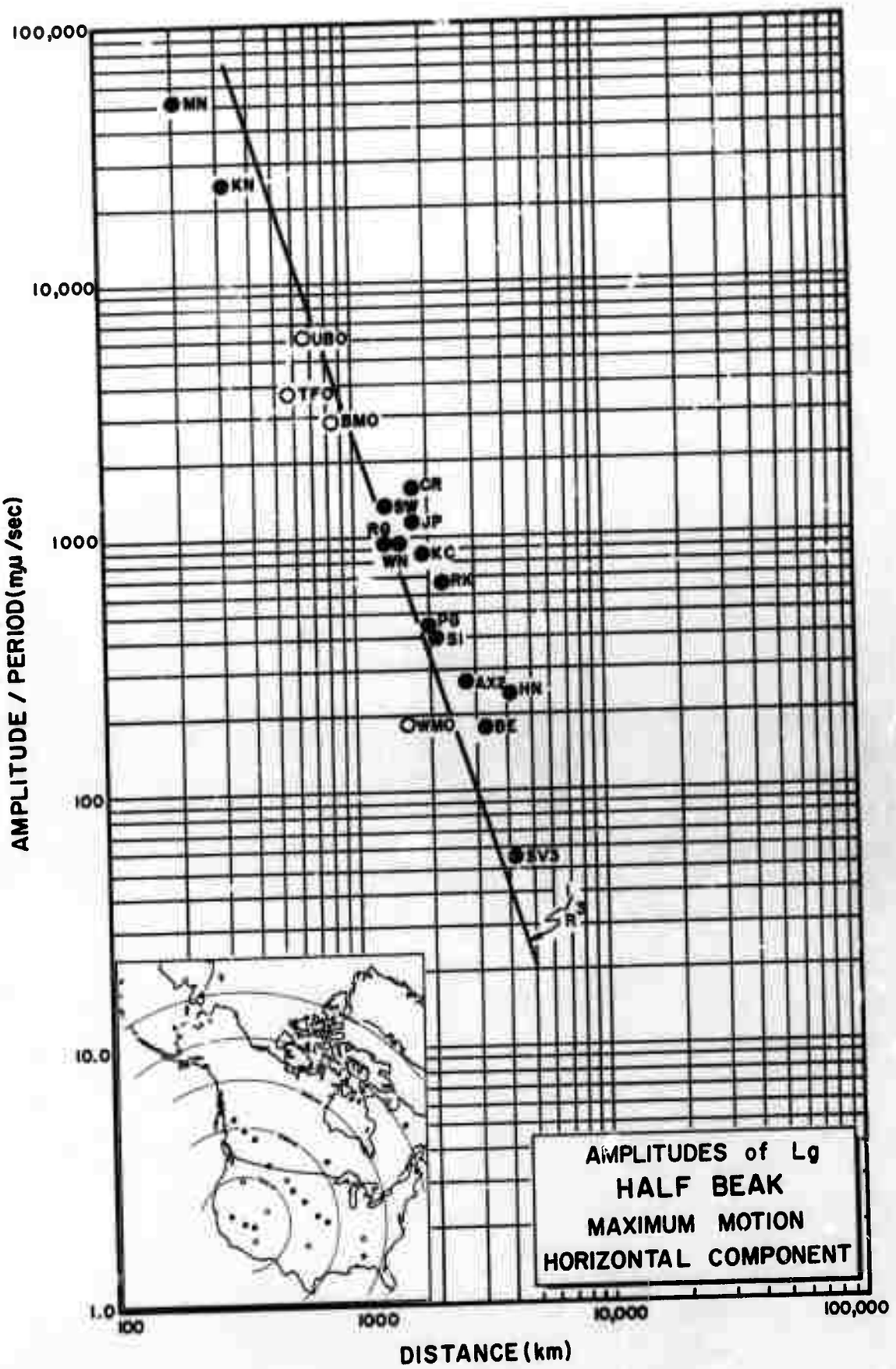

100,000
10,000
1000
100
10.0
1.0
AMPLITUDE / PERIOD(mμ/sec)
MN
KN
UBO
TFO
BMO
CR
SW
JP
RG
WN
KC
RK
PS
SI
AXE
HN
WMO
BE
SV3
R
AMPLITUDES of Lg
HALF BEAK
MAXIMUM MOTION
HORIZONTAL COMPONENT
100
1000
10,000
100,000
DISTANCE (km)

Figure 6

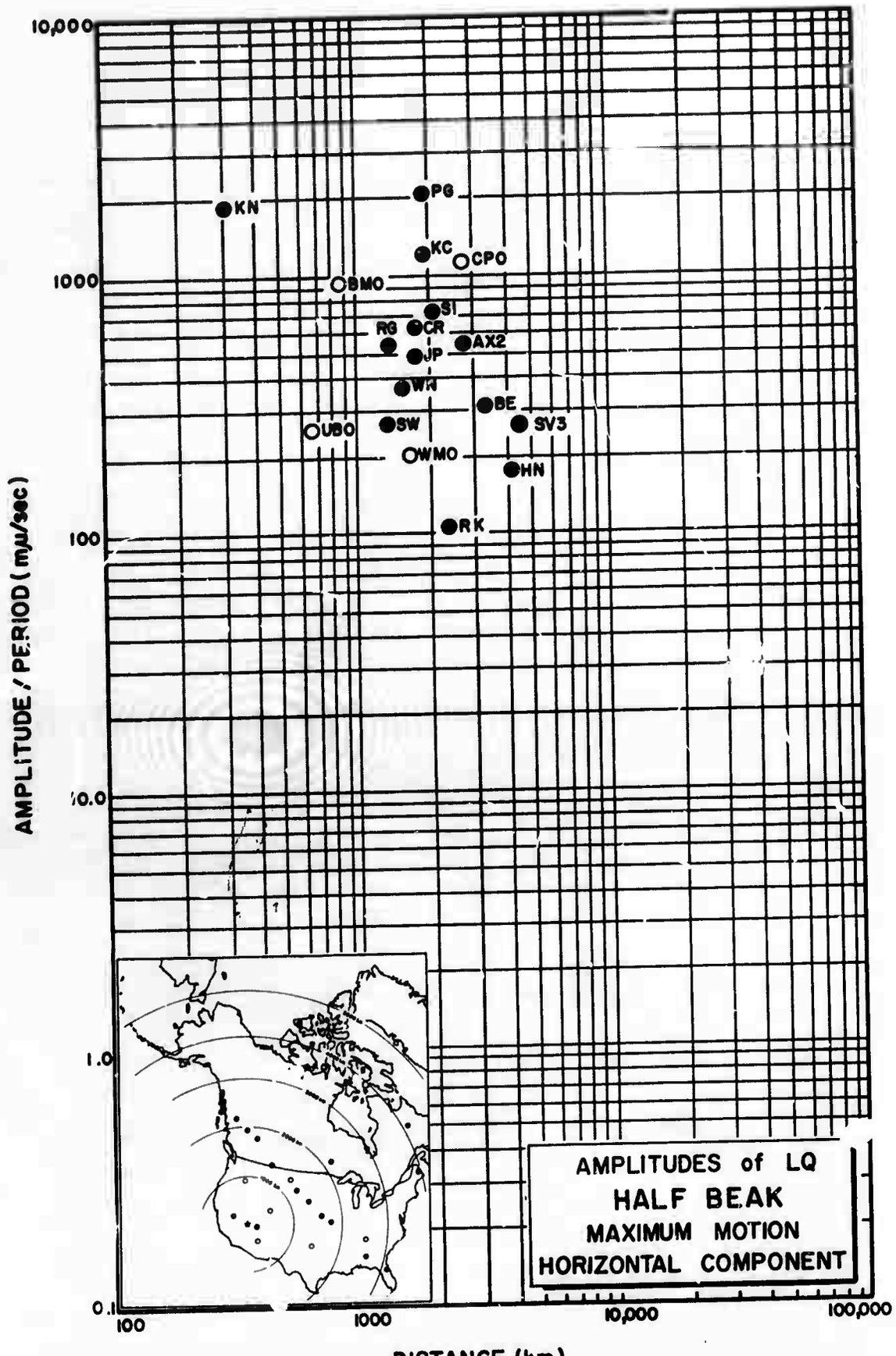

10,000
1000
100
10.0
1.0
0.1
AMPLITUDE / PERIOD (mμ/sec)
KN
PG
KC
CPO
BMO
SI
RG
CR
AX2
JP
WR
BE
SV3
UBO
SW
WMO
HN
RK
AMPLITUDES of LQ
HALF BEAK
MAXIMUM MOTION
HORIZONTAL COMPONENT
100
1000
10,000
100,000
DISTANCE (km)

Figure 7

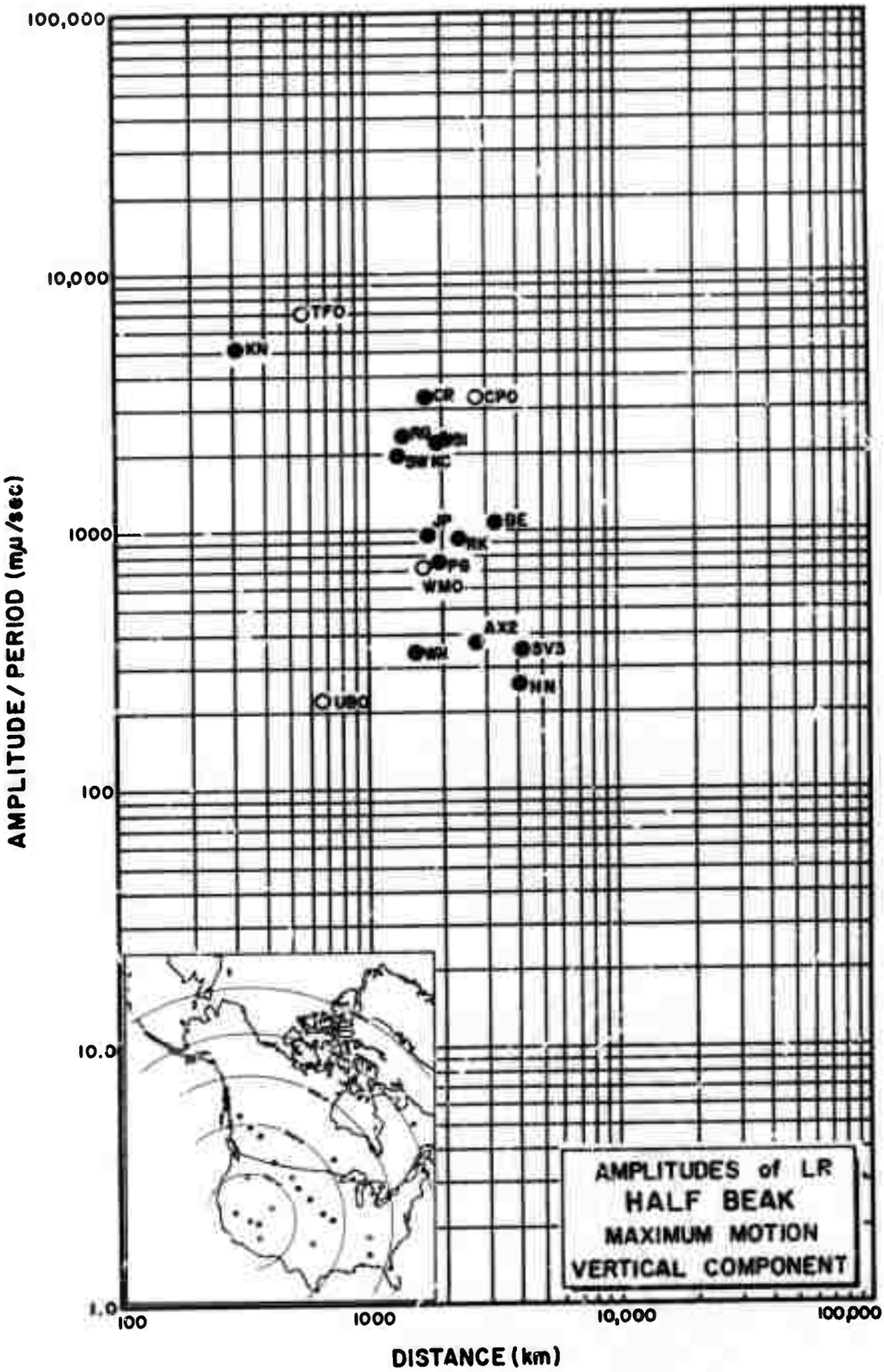

100,000
10,000
1000
100
10.0
1.0
AMPLITUDE/PERIOD (mμ/sec)
TFO
KN
CR
CPO
SW
KC
JP
BE
RK
PS
WMO
AX2
SV3
HN
UBO
100
1000
10,000
100,000
DISTANCE (km)
AMPLITUDES of LR
HALF BEAK
MAXIMUM MOTION
VERTICAL COMPONENT

Figure 8

Code	Station	Distance (km)	Geographic Latitude	Geographic Longitude	Elev. (km)	Computed Azimuth		Installed Azimuth		Large or Small SP	LP Inst.
						Epi. Sta.	Sta. Epi.	Radial	Tang.		
MN-NV	Mina, Nevada	205	38°26'10" N	118°08'53" W	1.52	308°	127°	308°	38°	L	X
KN-UT	Kanab, Utah	310	37°01'22" N	112°49'39" W	1.71	95°	277°	95°	185°	L	X
TF3O-Z1*	Tonto Forest Observatory, Arizona	565	34°17'12" N	111°16'03" W	1.49	125°	308°	90°	0°	JM	X
UBBO-Z10*	Uinta Basin Observatory, Utah	673	40°19'18" N	109°34'07" W	1.60	58°	242°	90°	0°	JM	X
BMBO-Z3*	Blue Mountain Observatory, Oregon	841	44°50'56" N	117°18'20" W	1.19	355°	174°	0°	90°	JM	X
LAO	Subarray AO-10, Montana	1333	46°41'19" N	106°13'20" W	.90	35°	222°			HSZ	
SW-MA*	Sweatgrass, Montana	1342	48°58'08" N	111°57'46" W	1.11	14°	197°	121°	211°	S	X
RG-SD*	Radig, South Dakota	1381	45°12'59" N	103°32'05" W	.95	47°	235°	127°	217°	L	X
WN-SD*	Winnar, South Dakota	1517	43°15'08" N	100°11'46" W	.79	59°	250°	129°	219°	L	X
WMSO-Z6*	Wichita Mountain Observatory, Oklahoma	1620	34°43'05" N	98°35'21" W	.51	95°	285°	90°	0°	JM	X
CR-NB	Crete, Nebraska	1722	40°39'52" N	96°51'15" W	.44	72°	264°	131°	221°	L	X
JP-AT*	Jasper, Alberta, Canada	1738	52°53'50" N	118°05'25" W	1.13	356°	175°	114°	204°	L	X
KC-MO*	Kansas City, Missouri	1900	39°21'21" N	94°40'17" W	.27	77°	270°	133°	223°	S	X
PG-BC*	Prince George, British Columbia, Canada	1916	53°59'50" N	122°31'23" W	.91	348°	163°	110°	200°	L	X
BI-BC*	Smithers, British Columbia, Canada	2109	54°47'18" N	127°04'17" W	.58	341°	153°	107°	197°	L	X
RK-ON	Red Lake, Ontario, Canada	2339	50°50'20" N	93°40'20" W	.37	43°	239°	58°	148°	S	X
CPBO-Z8*	Cumberland Plateau Observatory, Tennessee	2749	35°35'41" N	85°34'13" W	.57	85°	283°	90°	0°	JM	X
AX2AL*	Alexander City, Alabama	2786	32°46'38" N	86°07'48" W	.23	91°	289°	138°	228°	L	X
BE-FL*	Ballaviaw, Florida	3308	28°54'19" N	82°03'52" W	.02	96°	295°	140°	230°	S	X
HN-ME	Houlton, Maine	4073	46°09'43" N	67°59'09" W	.21	60°	274°	93°	183°	S	X
SV3QB*	Schaffarville, Quebec, Canada	4187	54°48'39" N	66°45'00" W	.58	46°	263°	139°	229°	S	X
NP-NT	Mould Bay, Northwest Tarritorias, Canada	4343	76°15'08" N	119°22'18" W	.06	359°	176°	356°	86°	JMZ S	X

*SEISMOMETERS NOT ORIENTATED TOWARD NEVADA TEST SITE

Recording Site Information - HALF BEAK

Appendix I(A)

Unified Magnitude: $m = \log_{10} (A/T), + B$

where

A = zero to peak ground motion in millimicrons
$= \frac{(mm)\ (1000)}{K}$

T = signal period in seconds

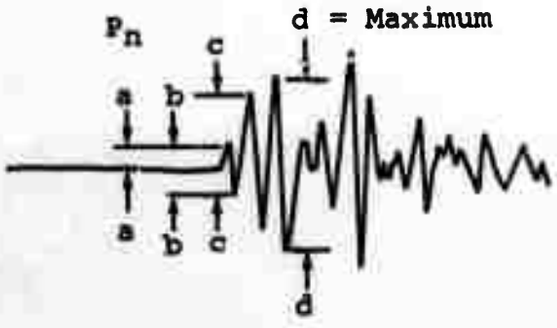
B = distance factor (see Table below)

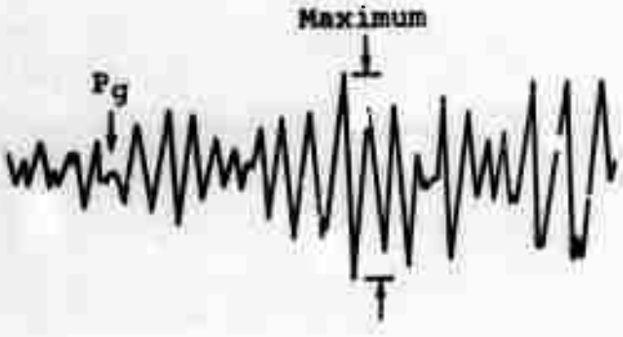
mm = record amplitude in millimeters zero to peak

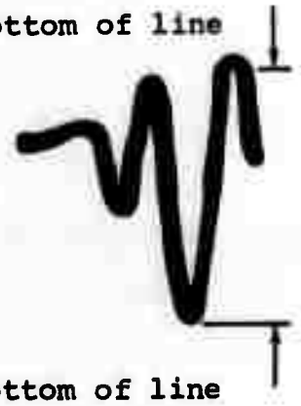
K = magnification in thousands at signal frequency

Table of Distance Factors (B) for Zero Depth

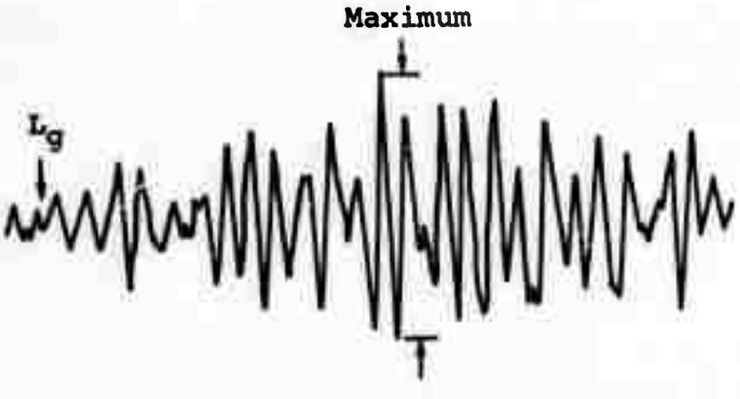
Dist (deg)	B	Dist (deg)	B	Dist (deg)	B	Dist (deg)	B
0°	-	27°	3.5	54°	3.8	80°	3.7
1	-	28	3.6	55	3.8	81	3.8
2	2.2	29	3.6	56	3.8	82	3.9
3	2.7	30	3.6	57	3.8	83	4.0
4	3.1	31	3.7	58	3.8	84	4.0
5	3.4	32	3.7	59	3.8	85	4.0
6	3.6	33	3.7	60	3.8	86	3.9
7	3.8	34	3.7	61	3.9	87	4.0
8	4.0	35	3.7	62	4.0	88	4.1
9	4.2	36	3.6	63	3.9	89	4.0
10	4.3	37	3.5	64	4.0	90	4.0
11	4.2	38	3.5	65	4.0	91	4.1
12	4.1	39	3.4	66	4.0	92	4.1
13	4.0	40	3.4	67	4.0	93	4.2
14	3.6	41	3.5	68	4.0	94	4.1
15	3.3	42	3.5	69	4.0	95	4.2
16	2.9	43	3.5	70	3.9	96	4.3
17	2.9	44	3.5	71	3.9	97	4.4
18	2.9	45	3.7	72	3.9	98	4.5
19	3.0	46	3.8	73	3.9	99	4.5
20	3.0	47	3.9	74	3.8	100	4.4
21	3.1	48	3.9	75	3.8	101	4.3
22	3.2	49	3.8	76	3.9	102	4.4
23	3.3	50	3.7	77	3.9	103	4.5
24	3.3	51	3.7	78	3.9	104	4.6
25	3.5	52	3.7	79	3.8	105	4.7
26	.4	53	3.7				







Detail Showing Allowance For Line Width



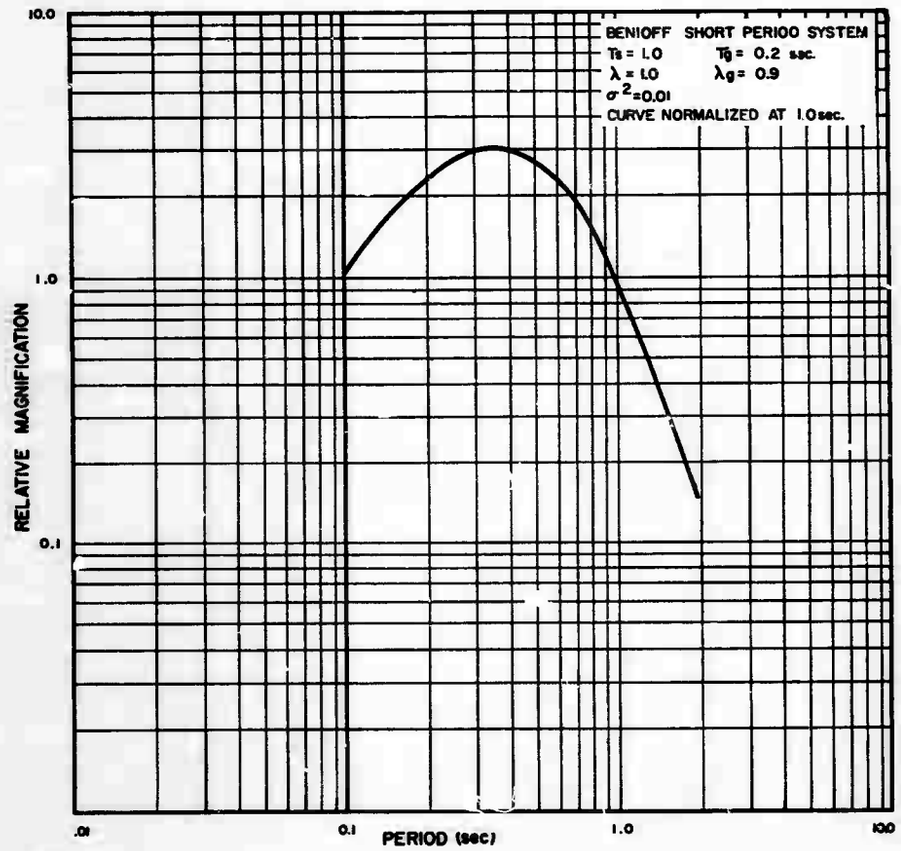
Pick <u>time</u> of <u>Pn</u> at beginning of "a" half cycle.

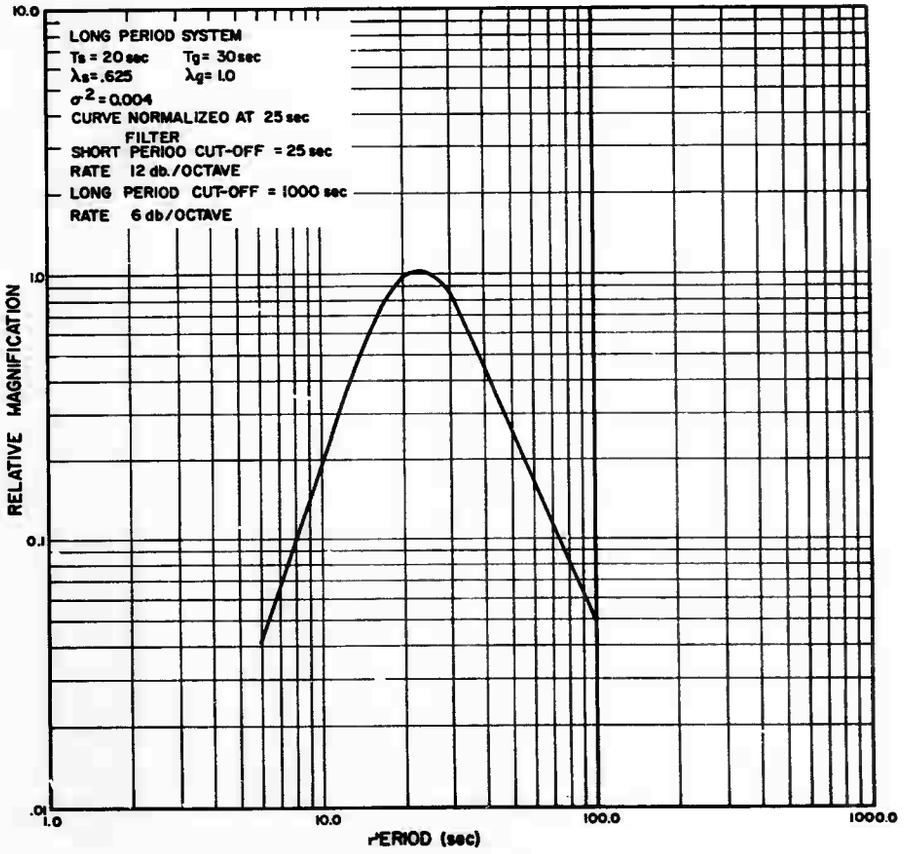
Pick <u>amplitude</u> of <u>Pn</u> as maximum "$d/2$" within 2 or 3 cycles of "c".

Pick <u>amplitudes</u> of <u>Pg</u> and <u>Lg</u> at maximum of corresponding motion.

Seismic Analysis Diagram

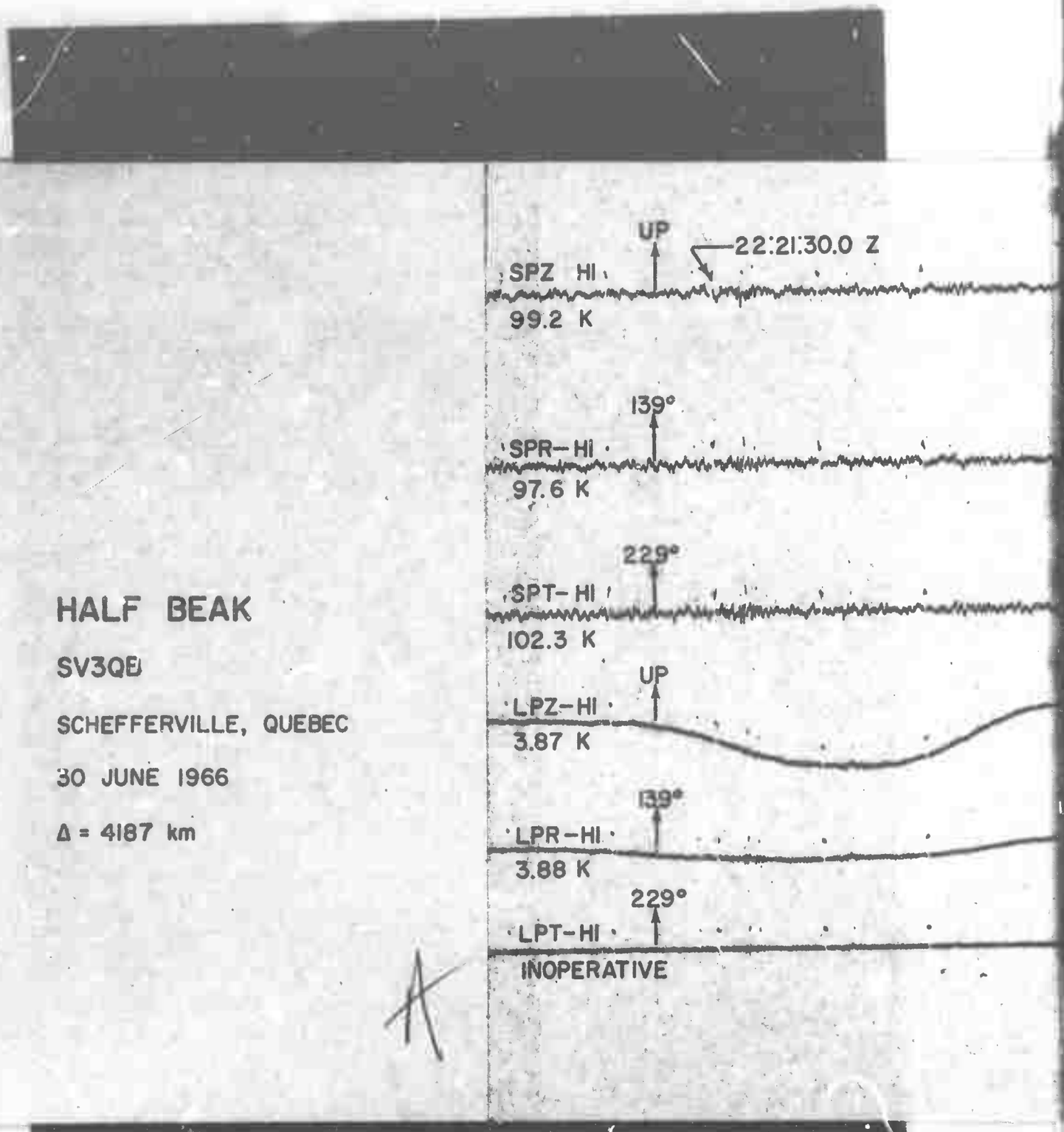
APPENDIX II(A)





INSTRUMENT RESPONSE CURVES - LRSM

Appendix II(B)



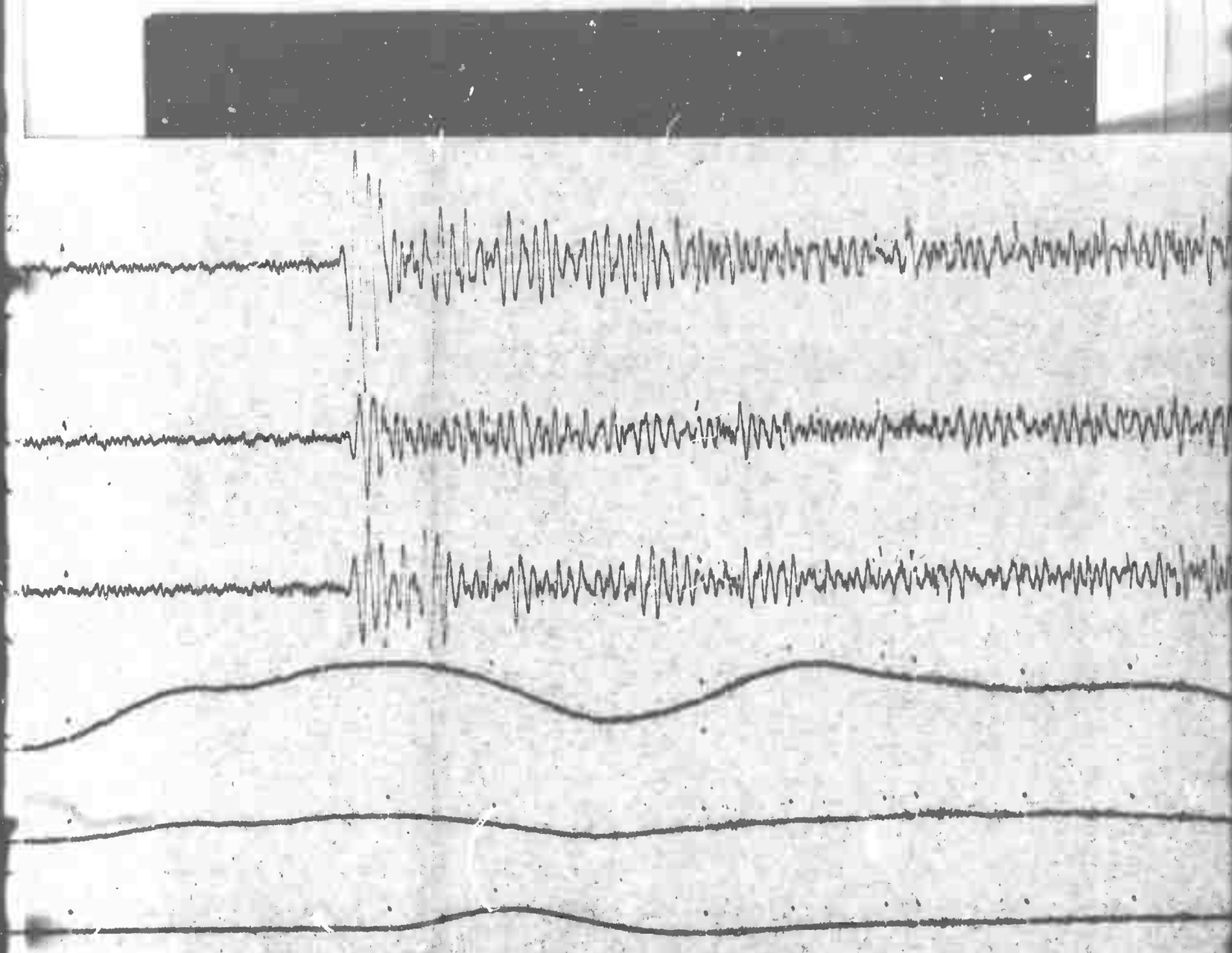
HALF BEAK

SV3QE

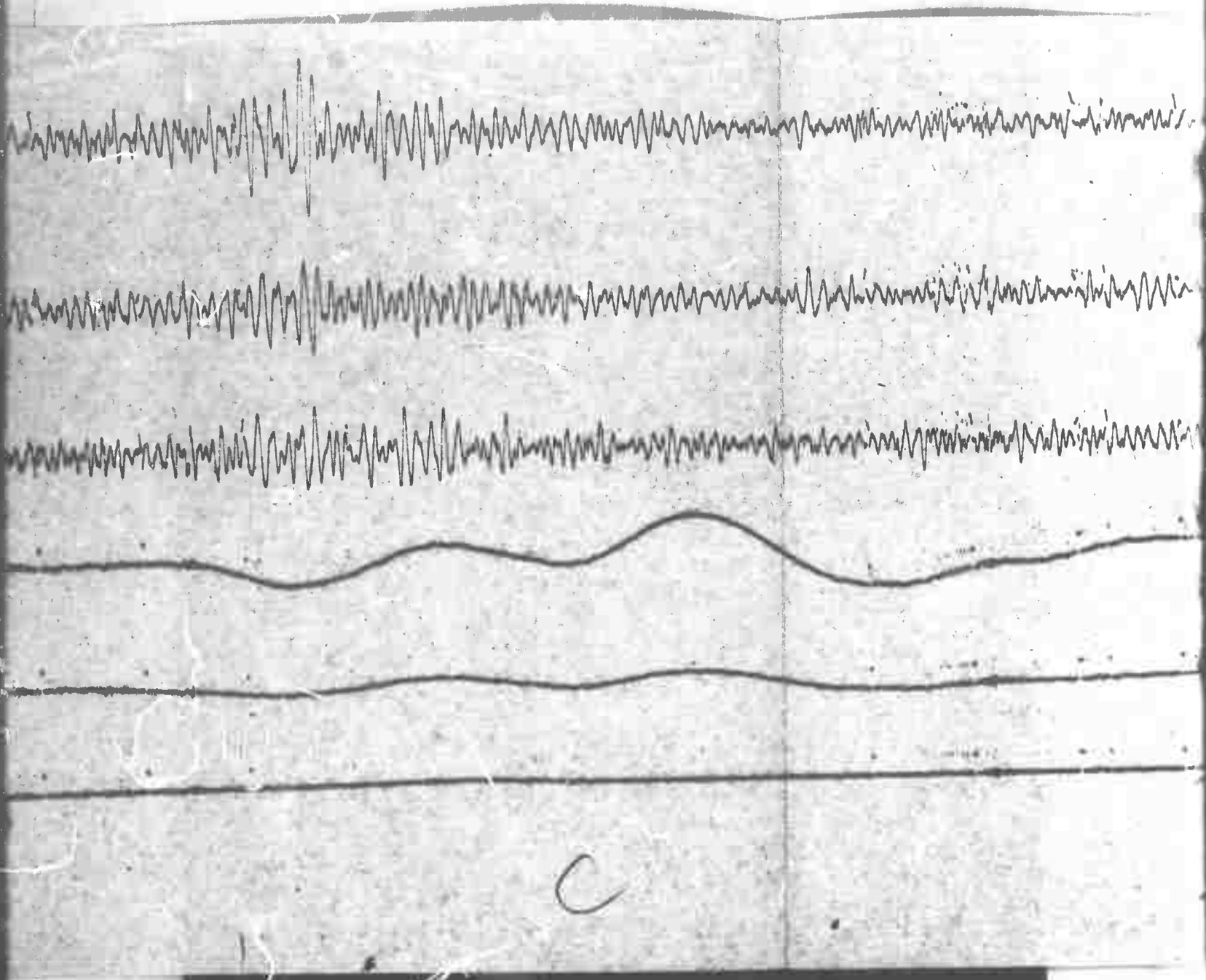
SCHEFFERVILLE, QUEBEC

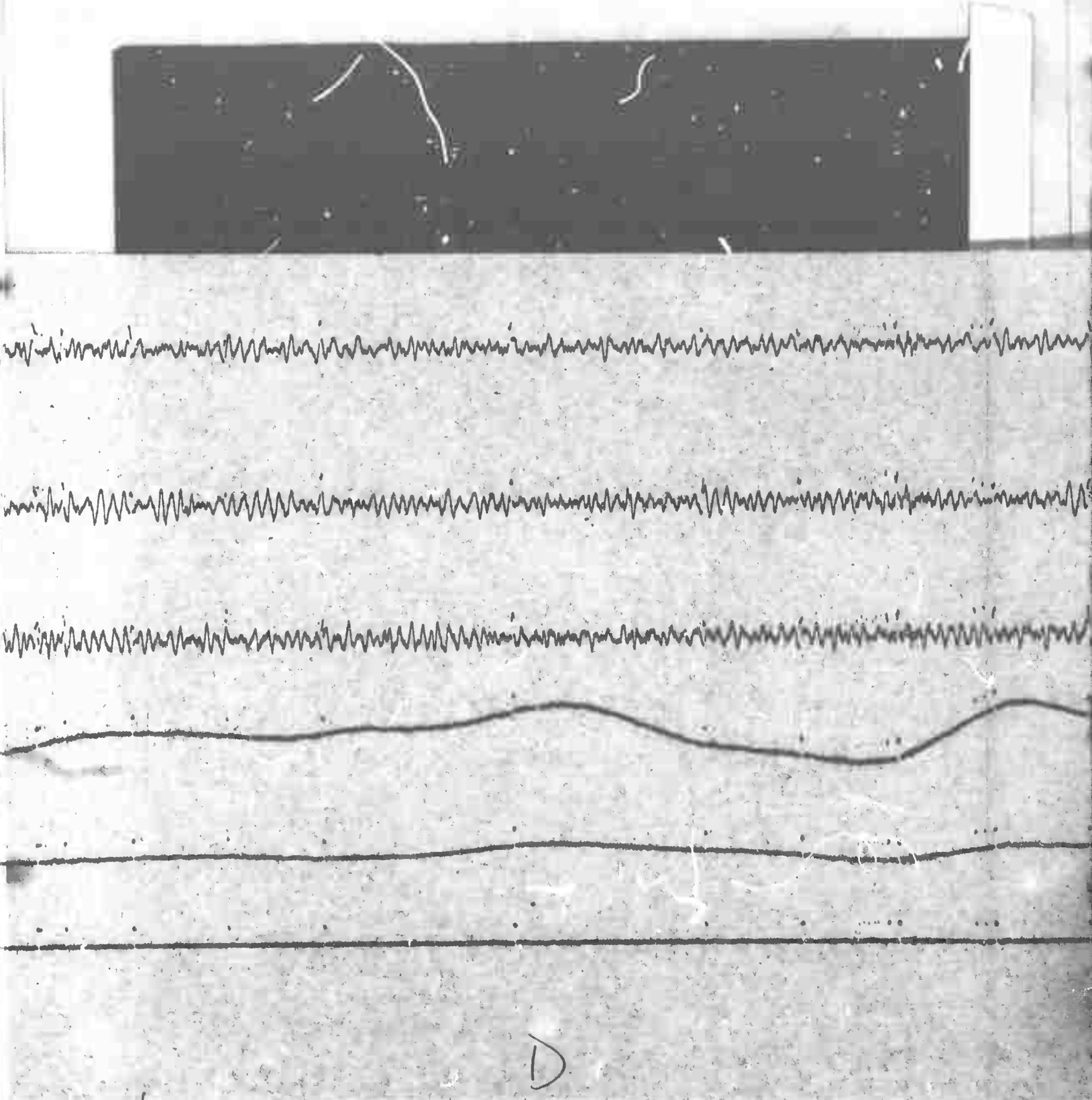
30 JUNE 1966

Δ = 4187 km

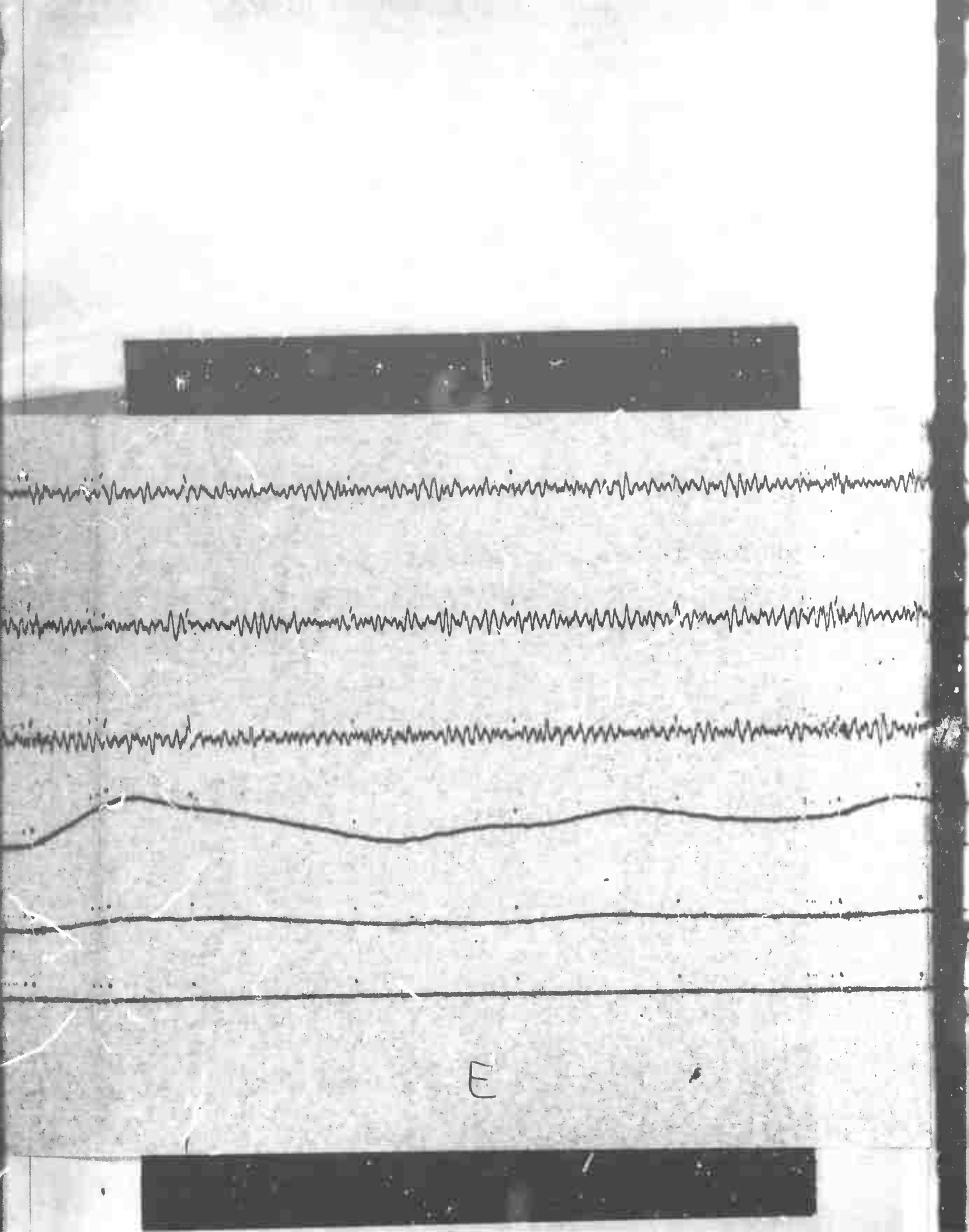


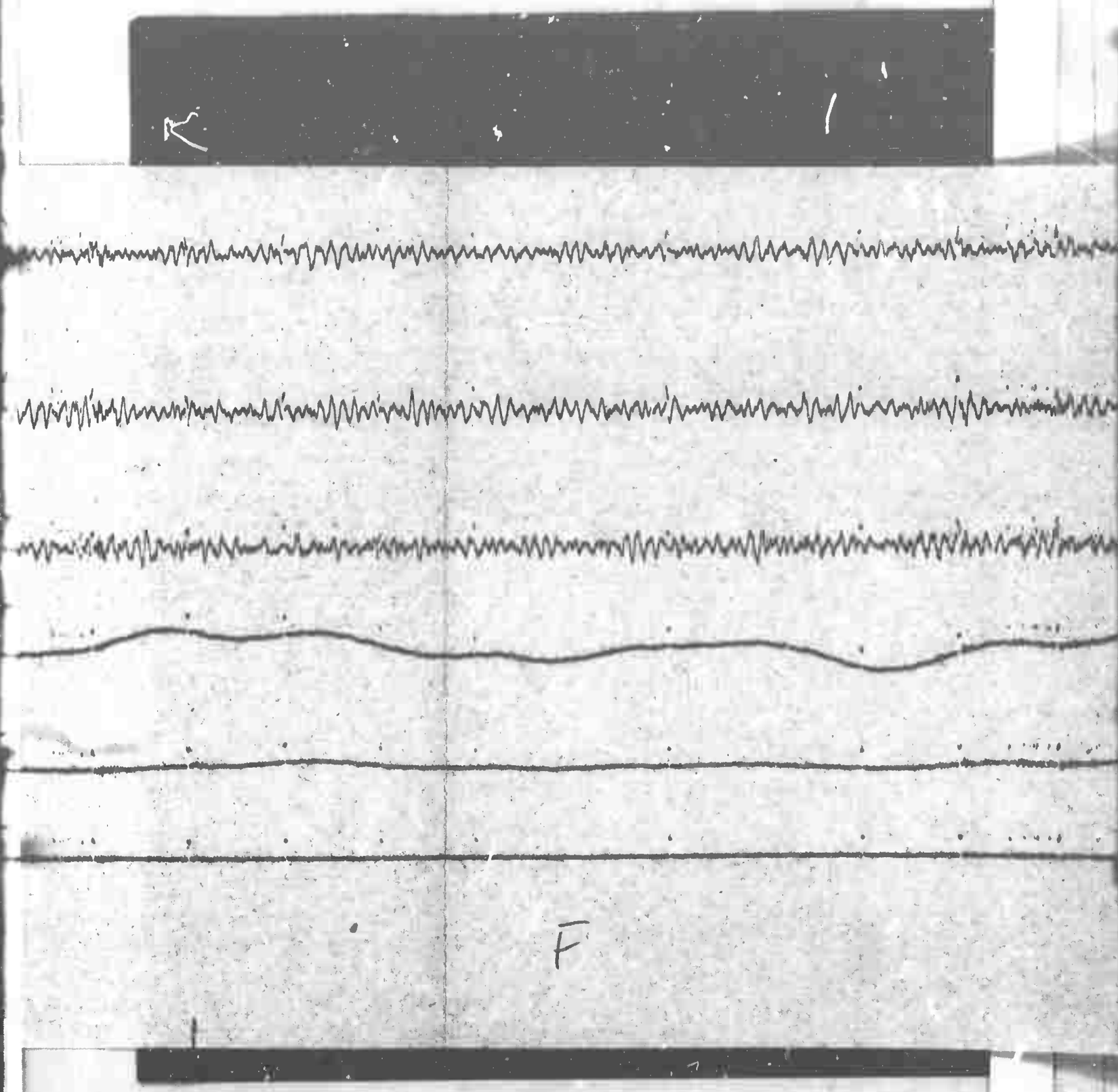
B

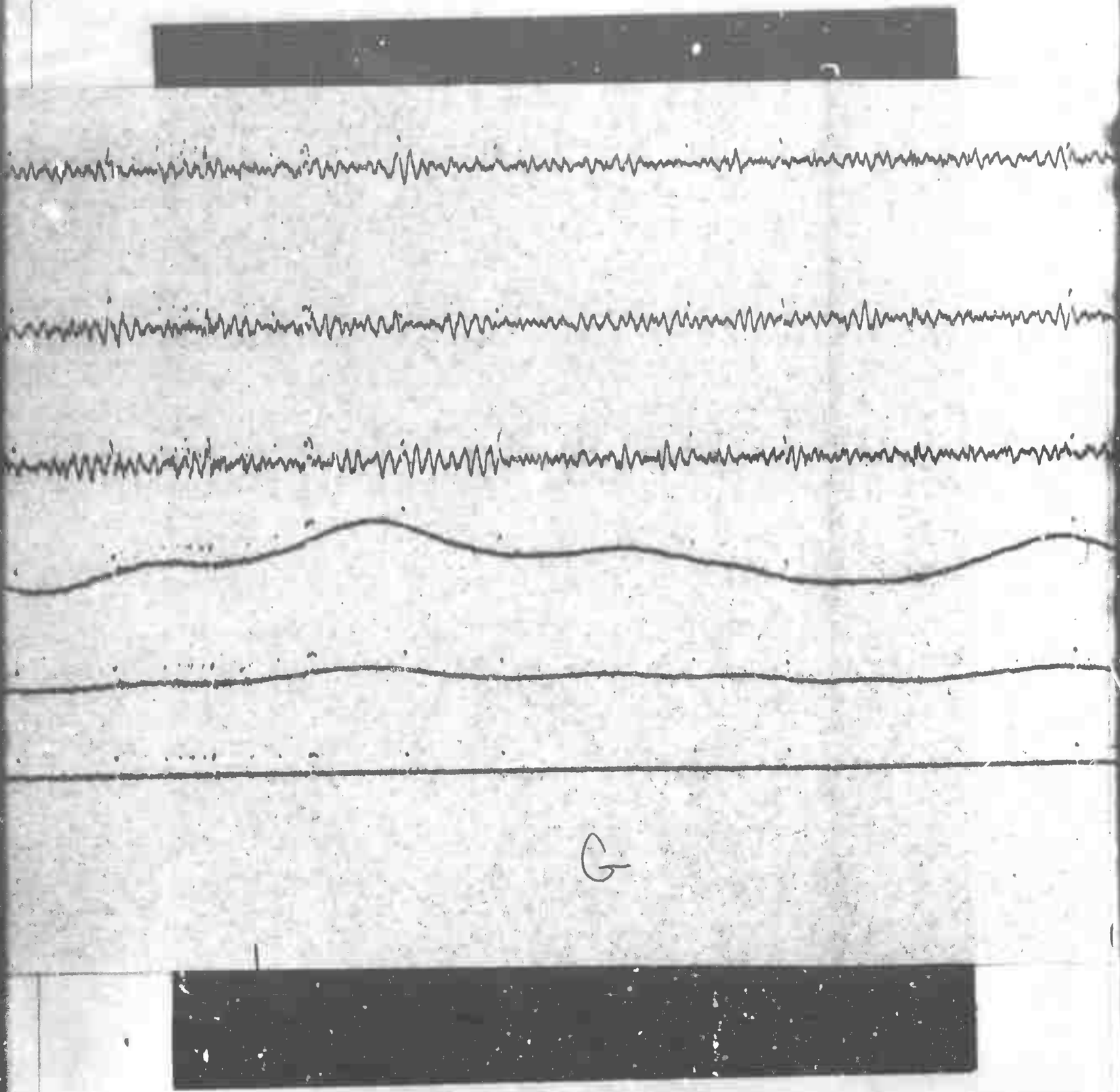


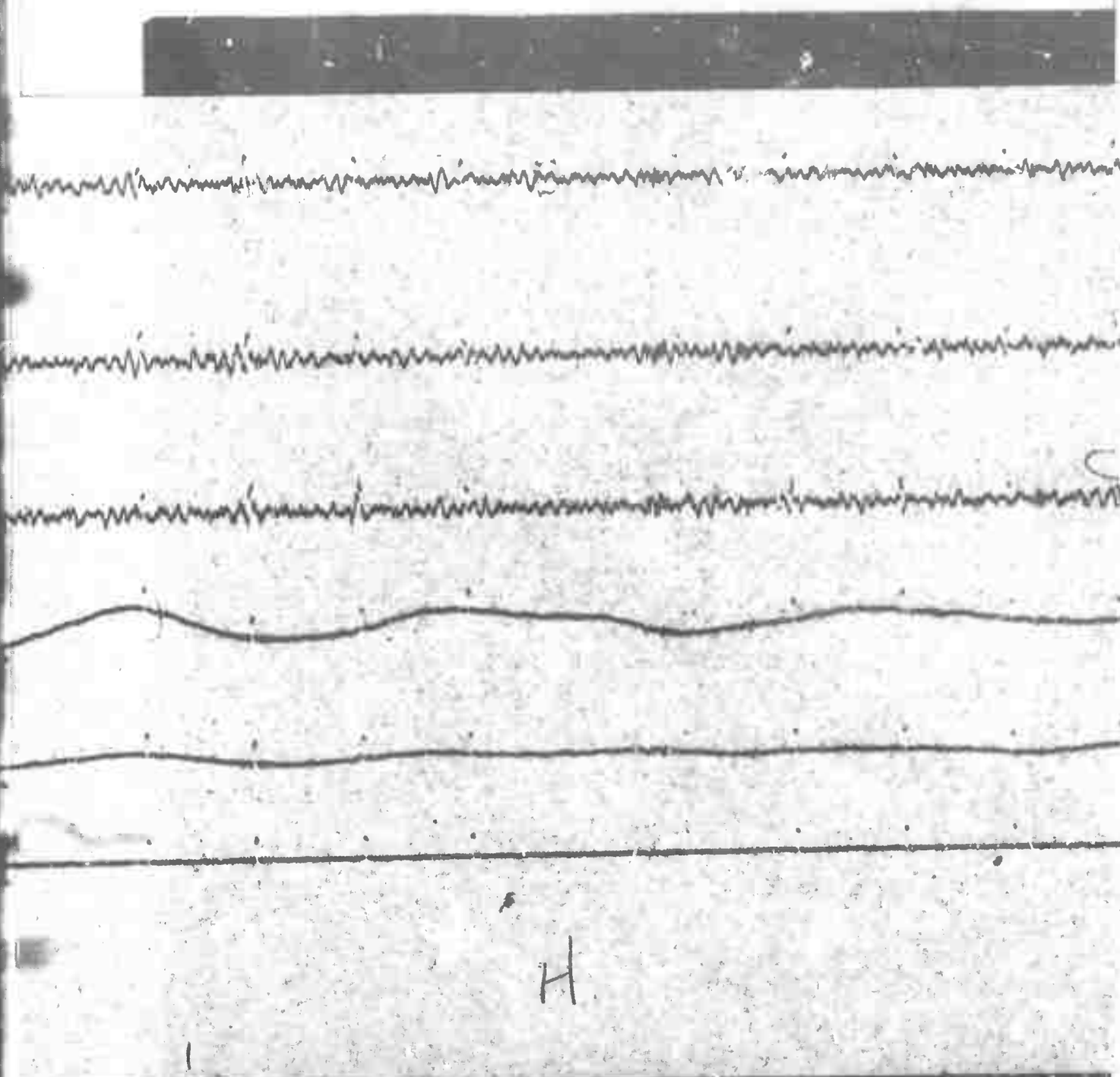


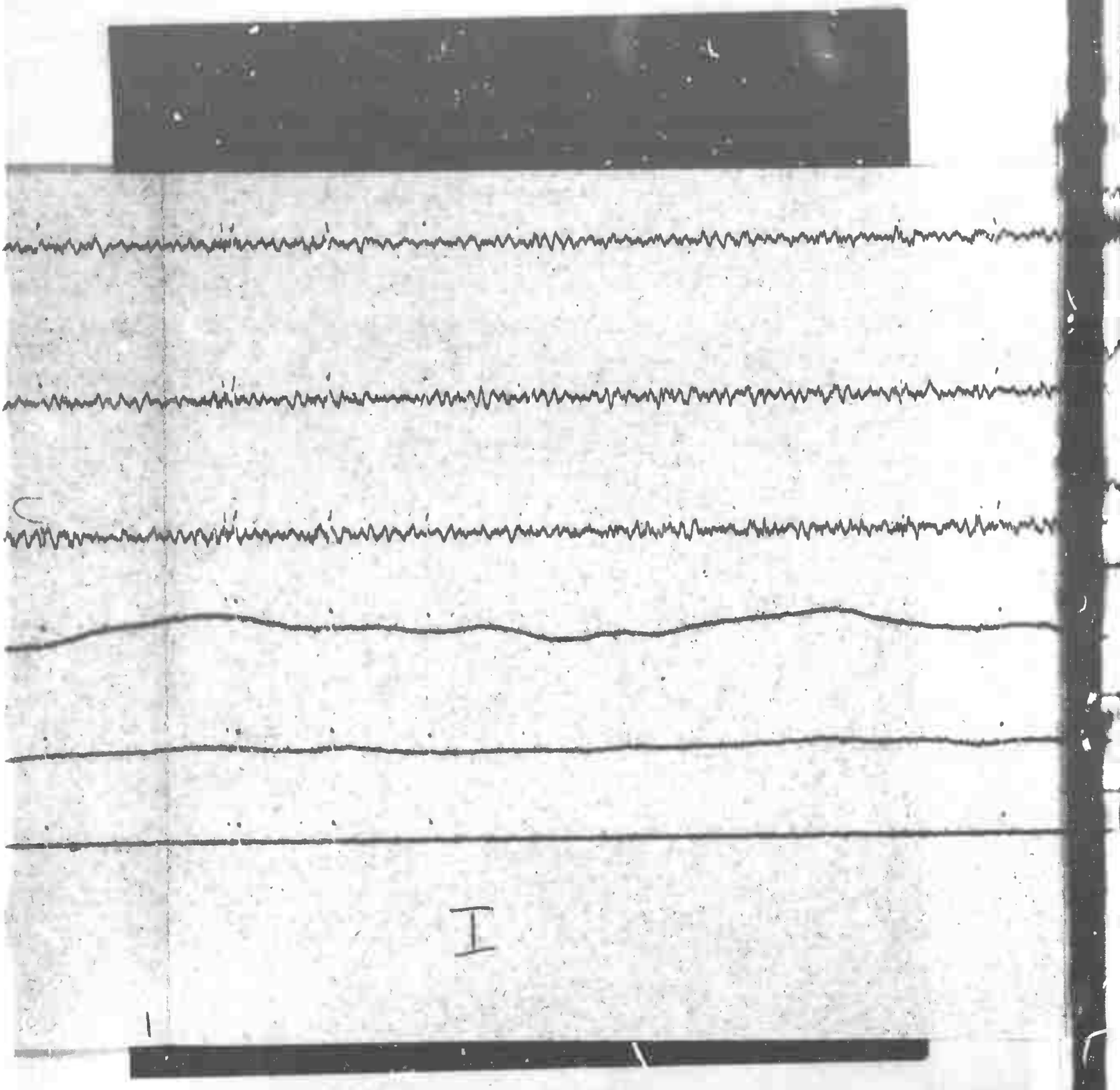
D

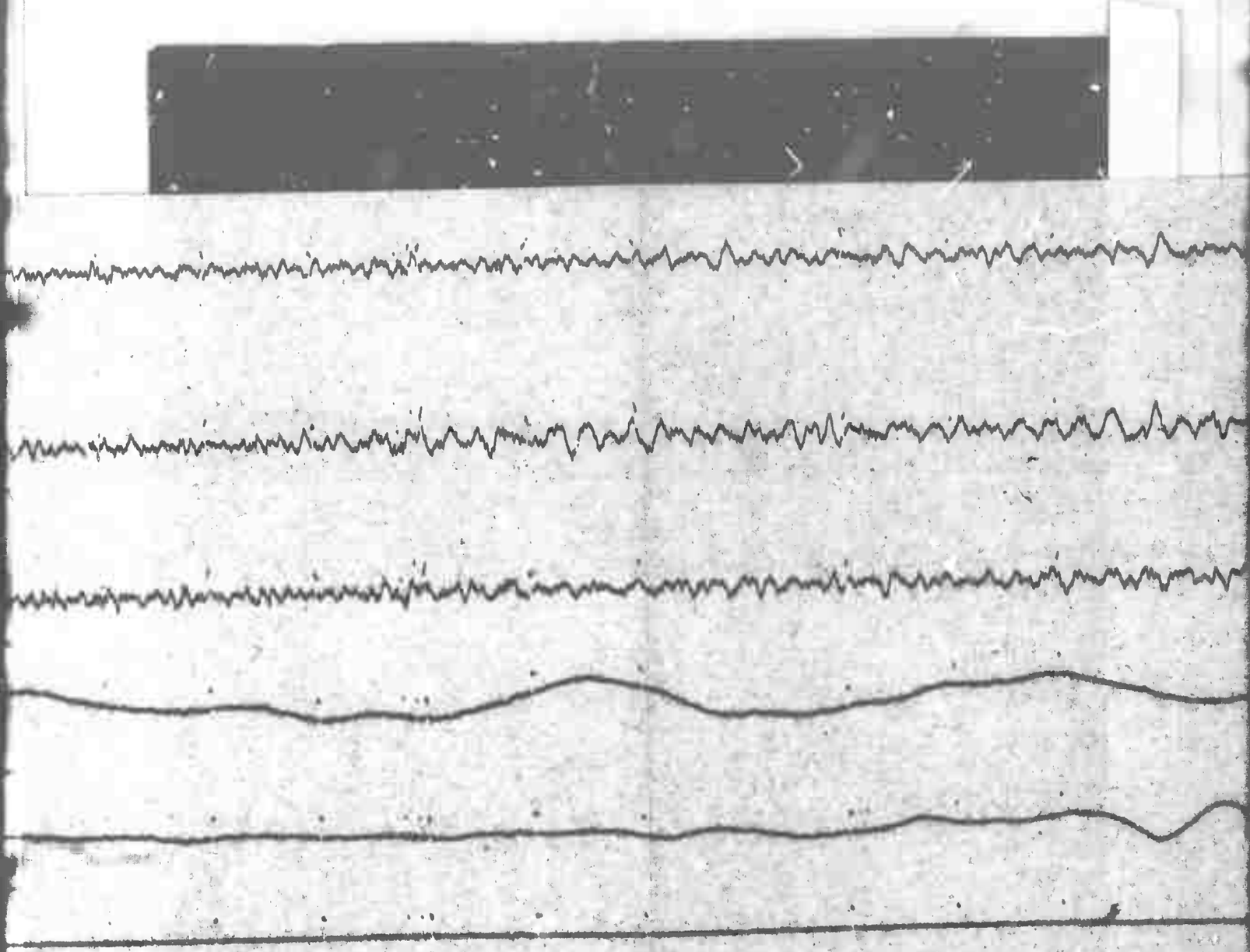

E

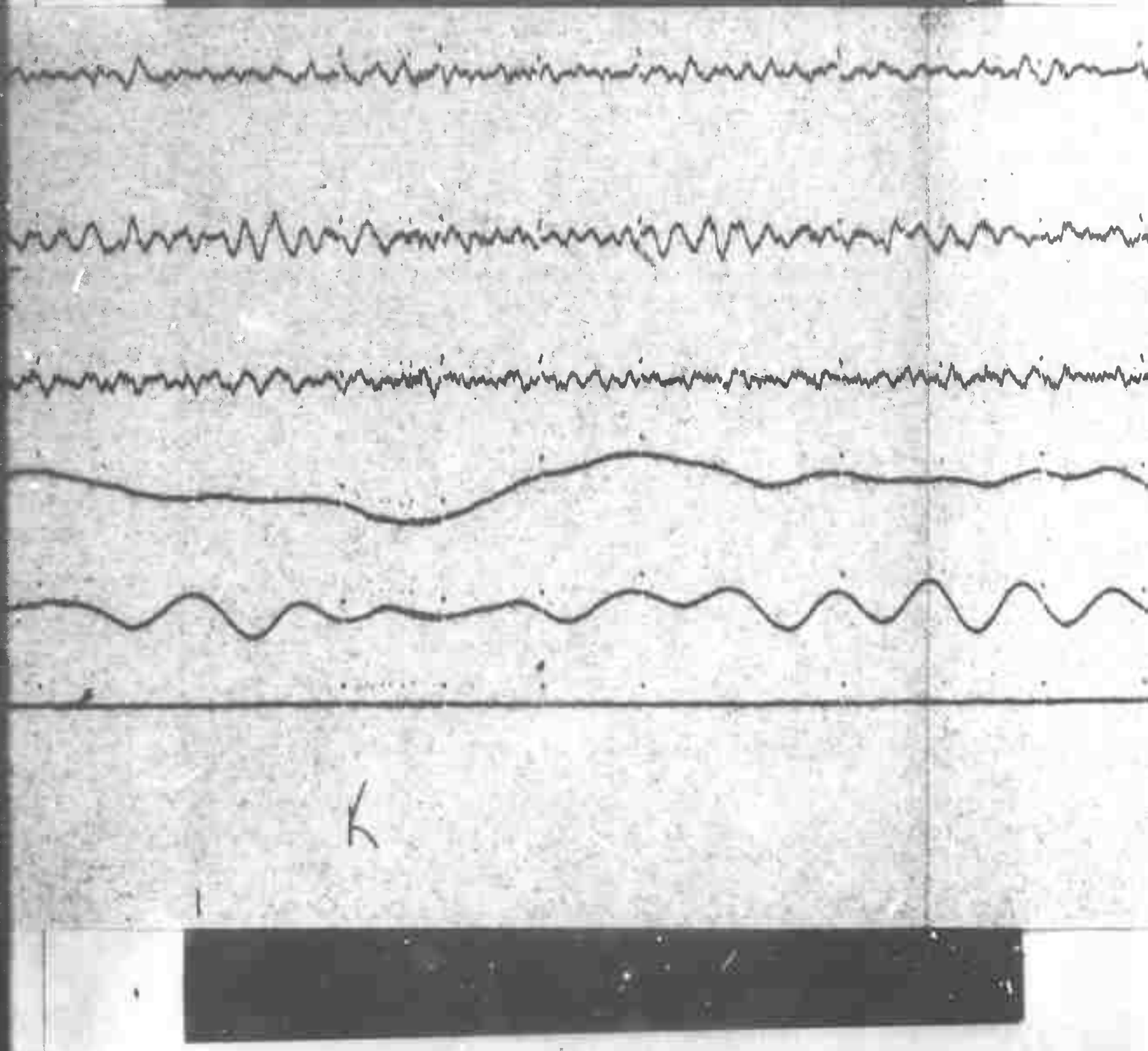

K
F

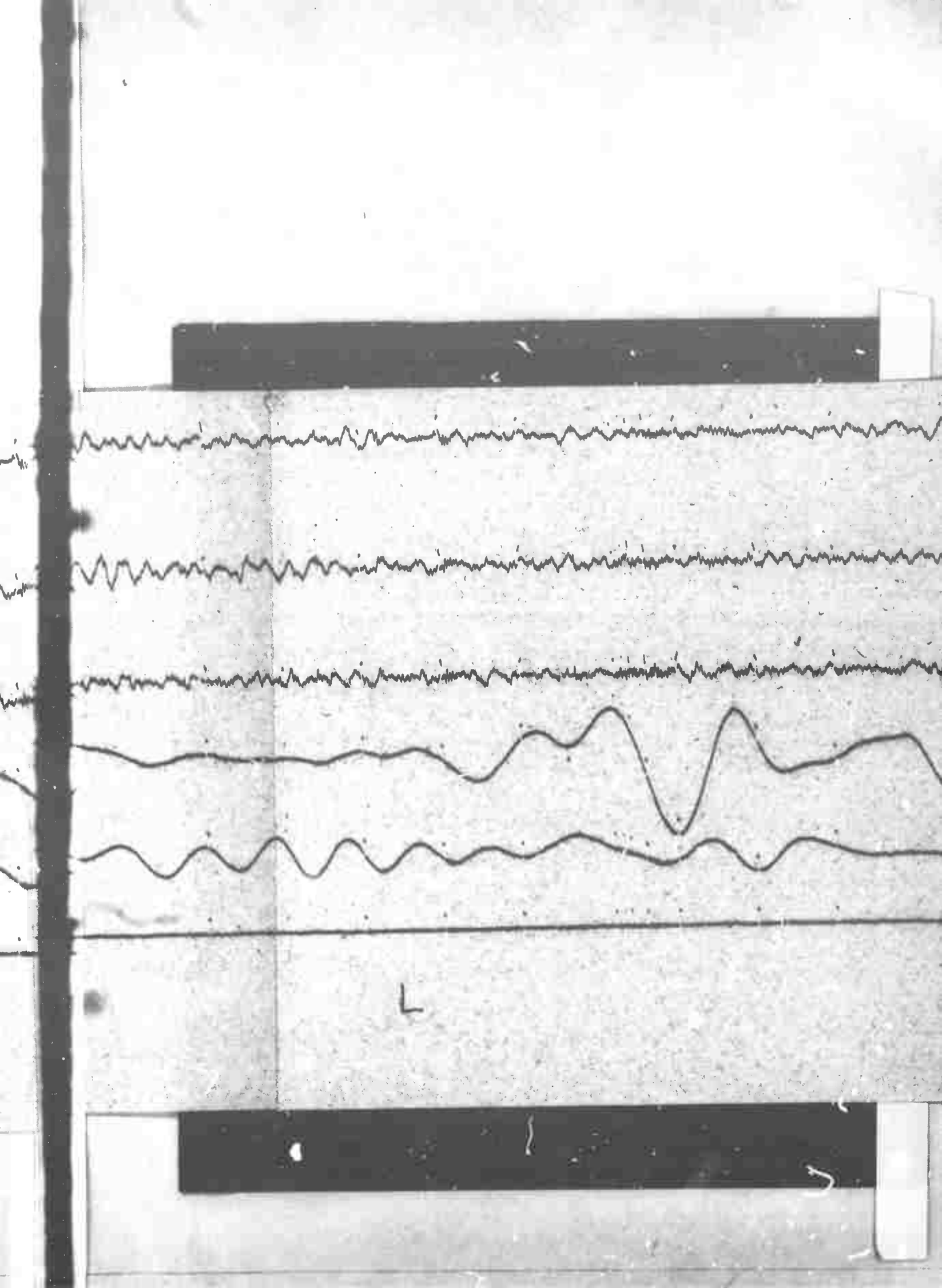

G

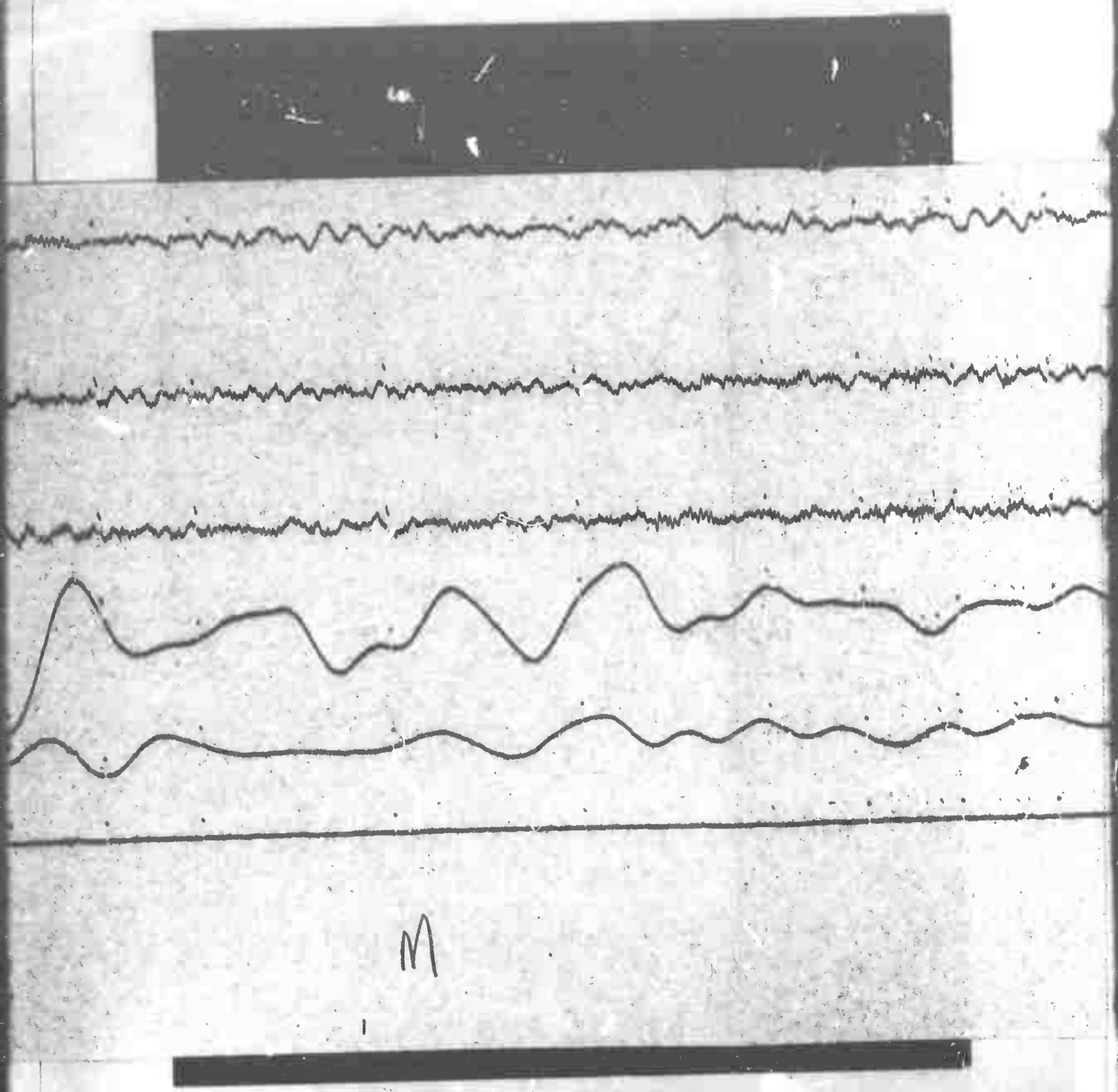


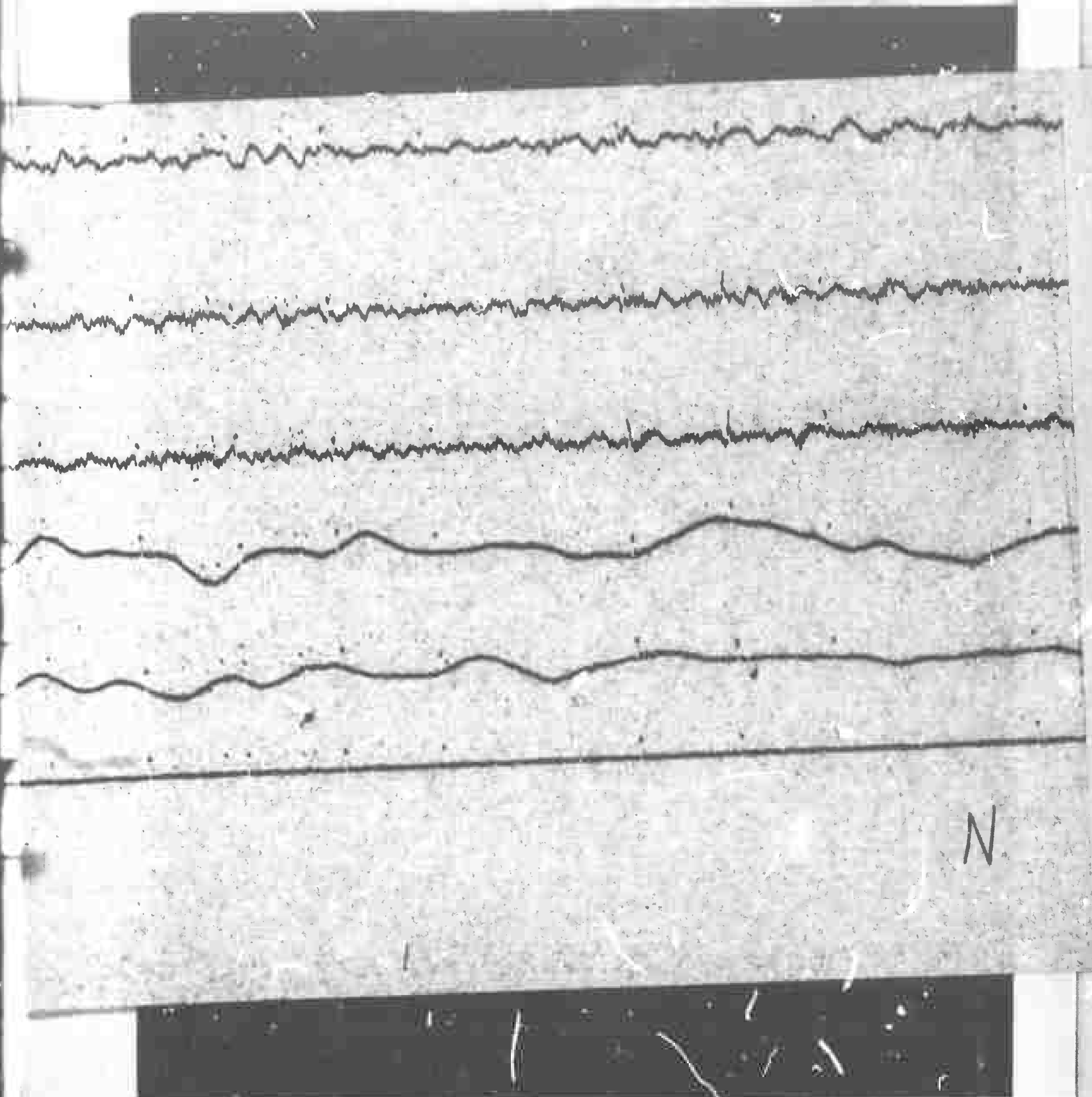

I




K




M


N

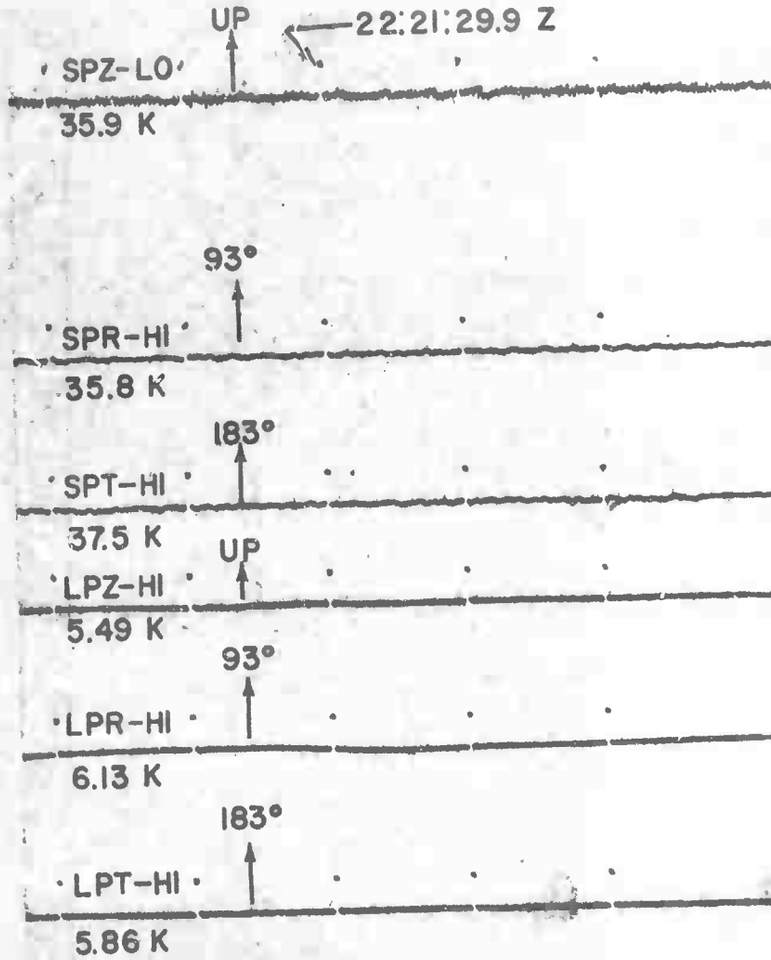
HALF BEAK

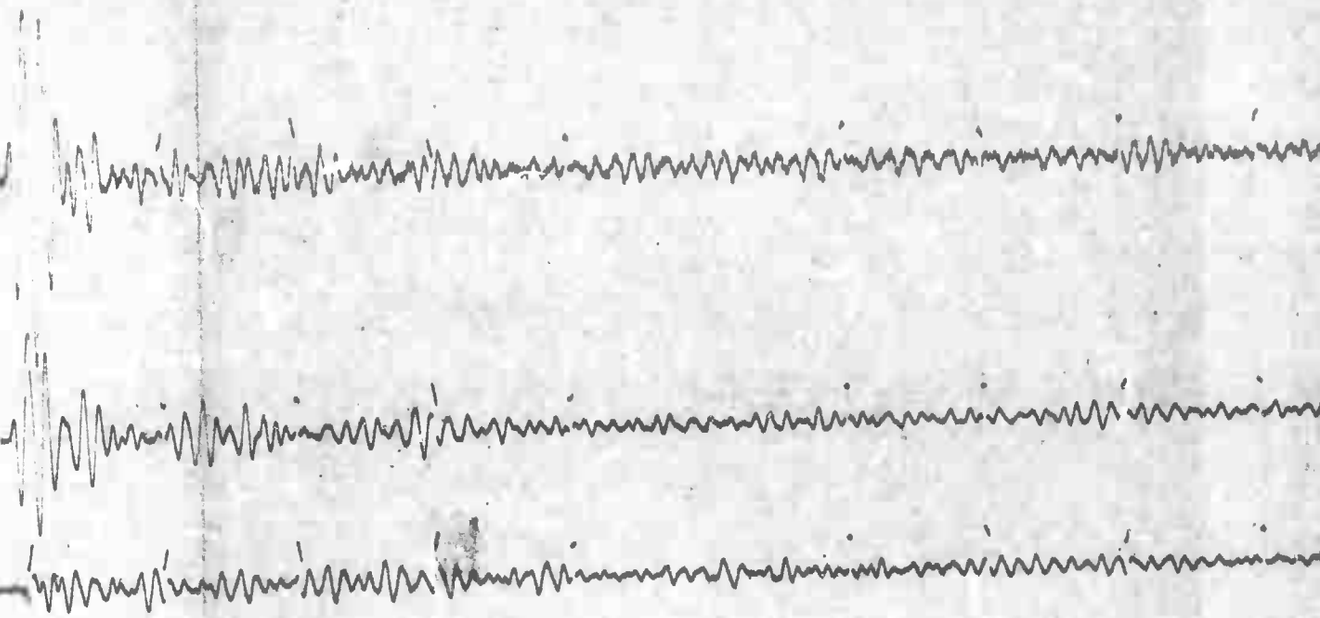
HN-ME

HOULTON, MAINE

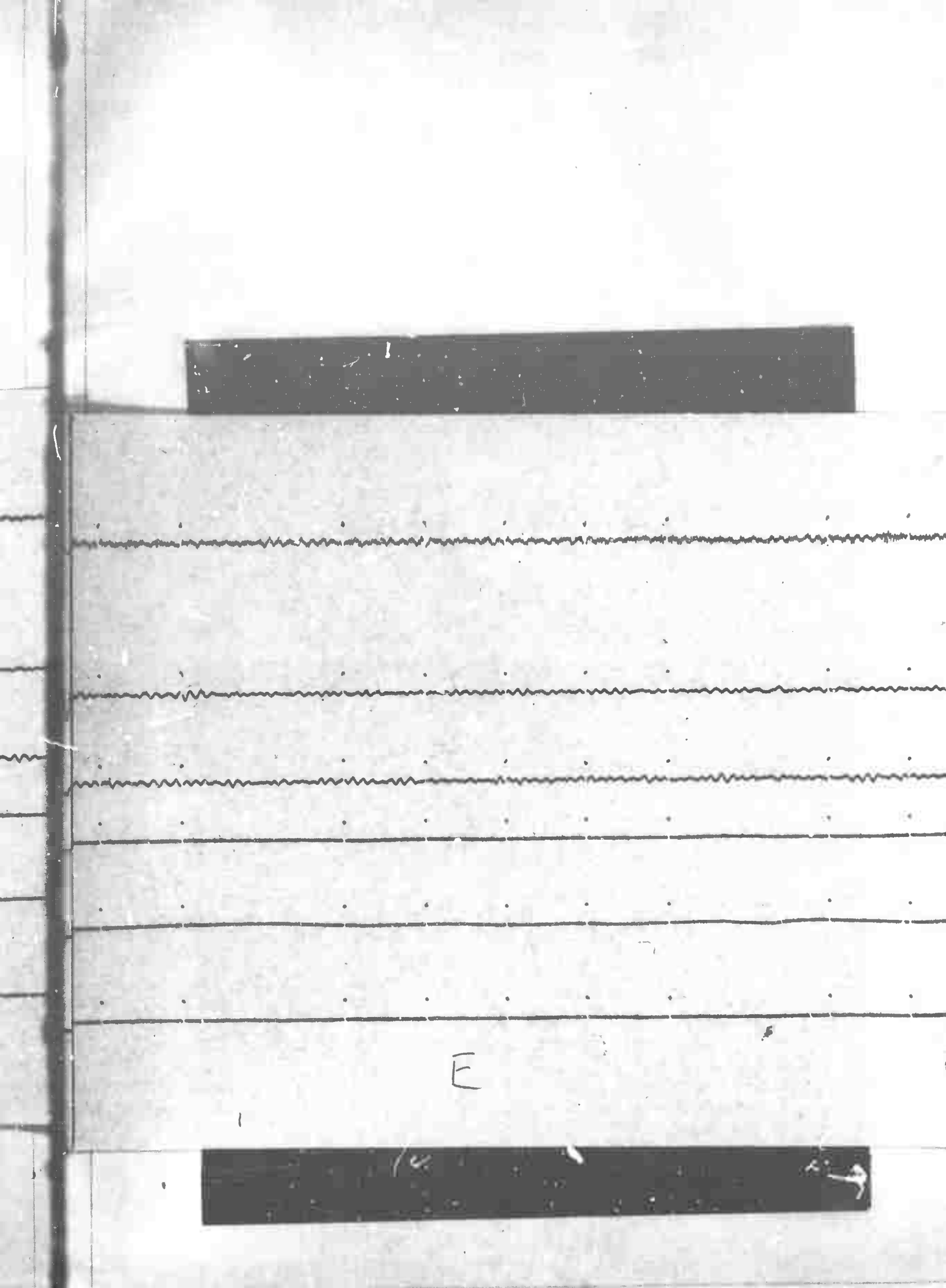
30 JUNE 1966

Δ = 4073 km

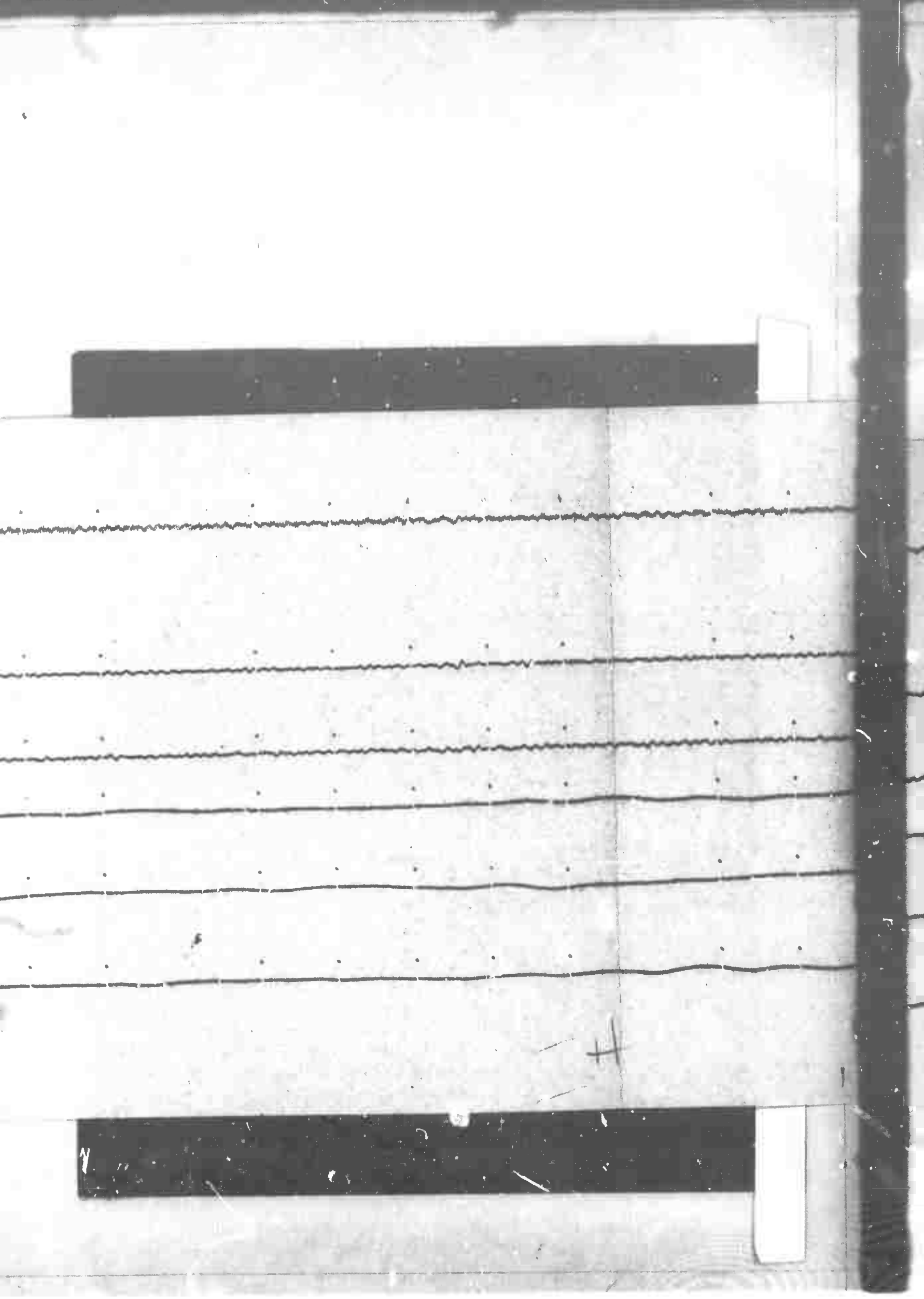




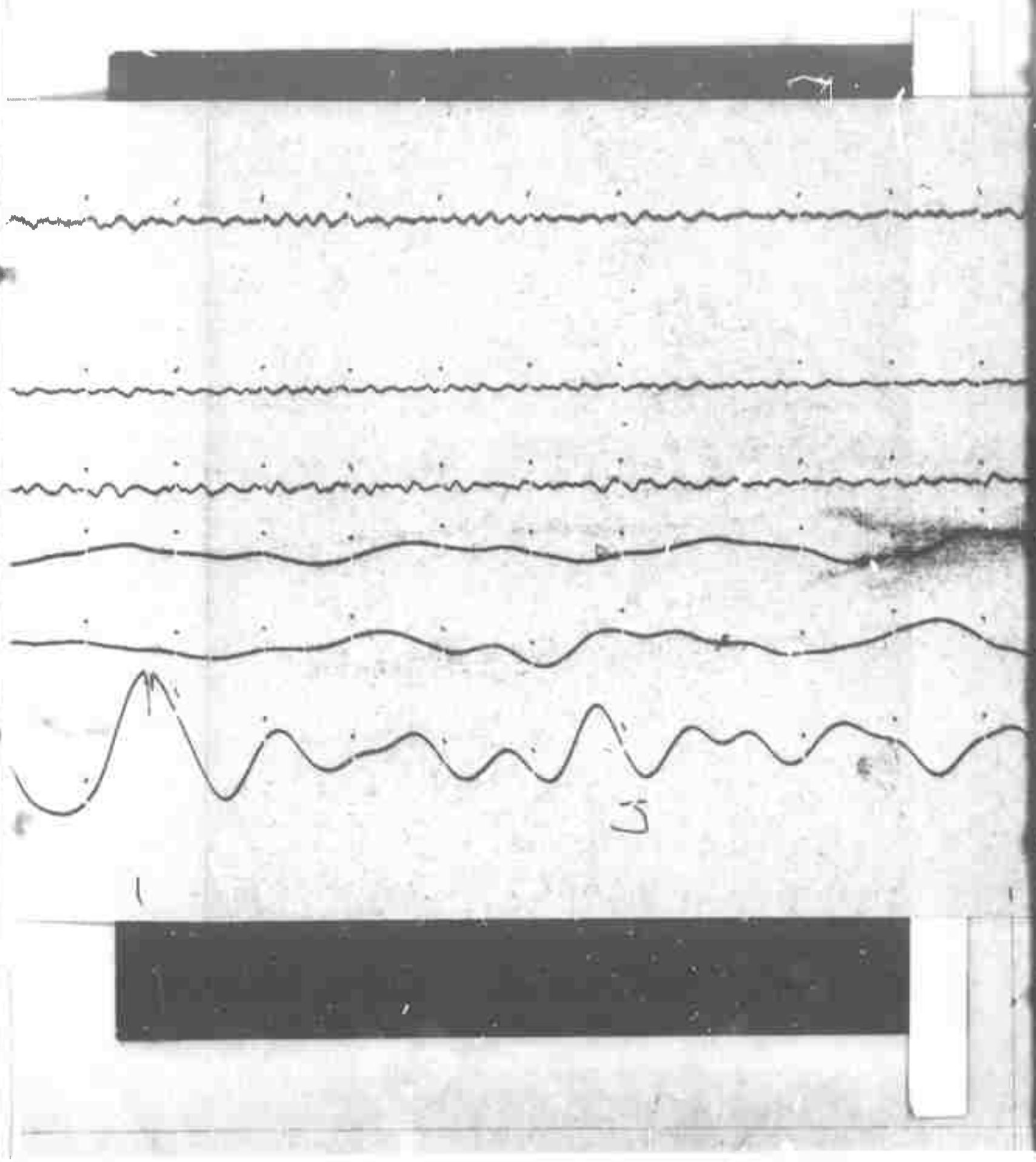
B

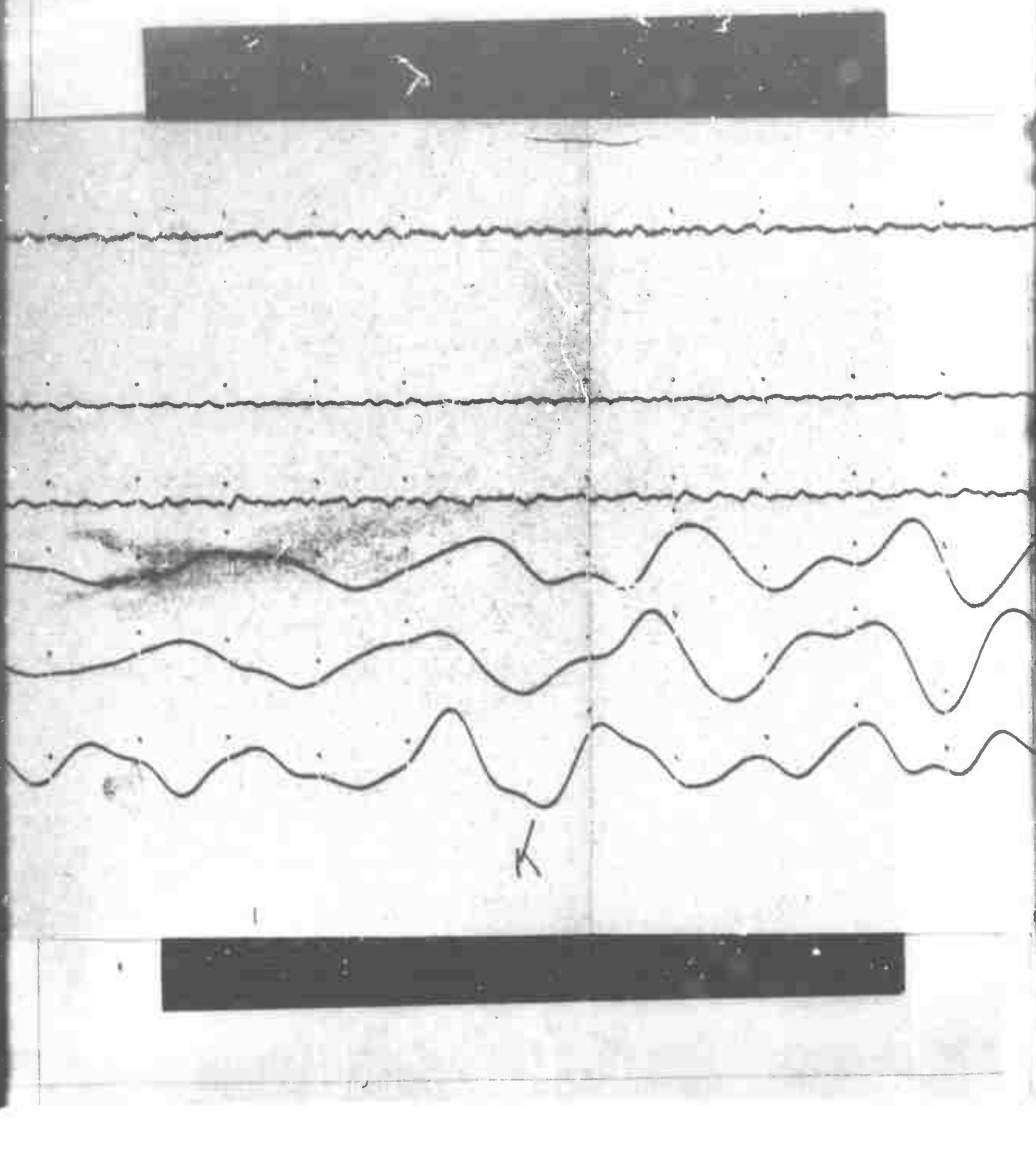


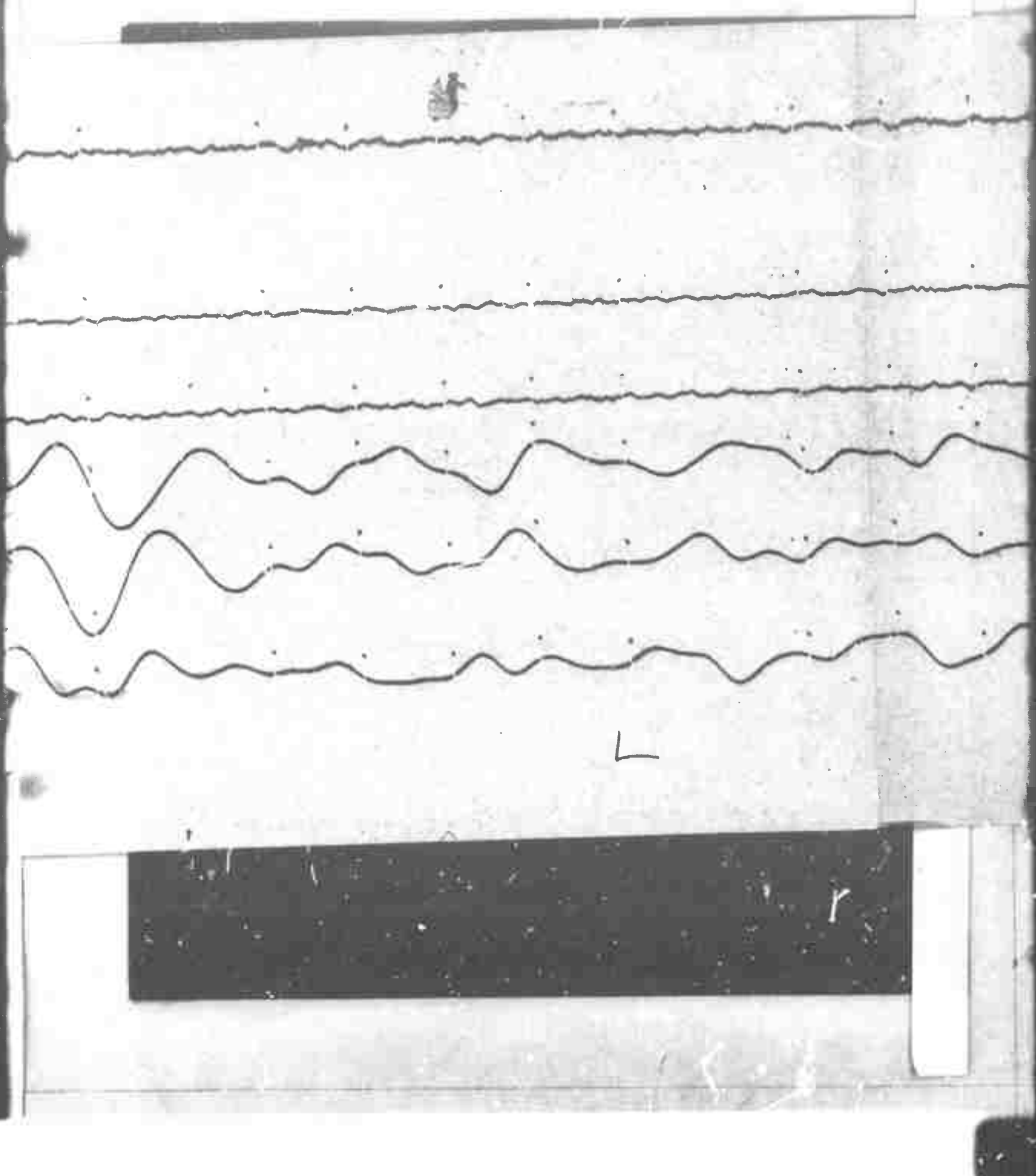

F

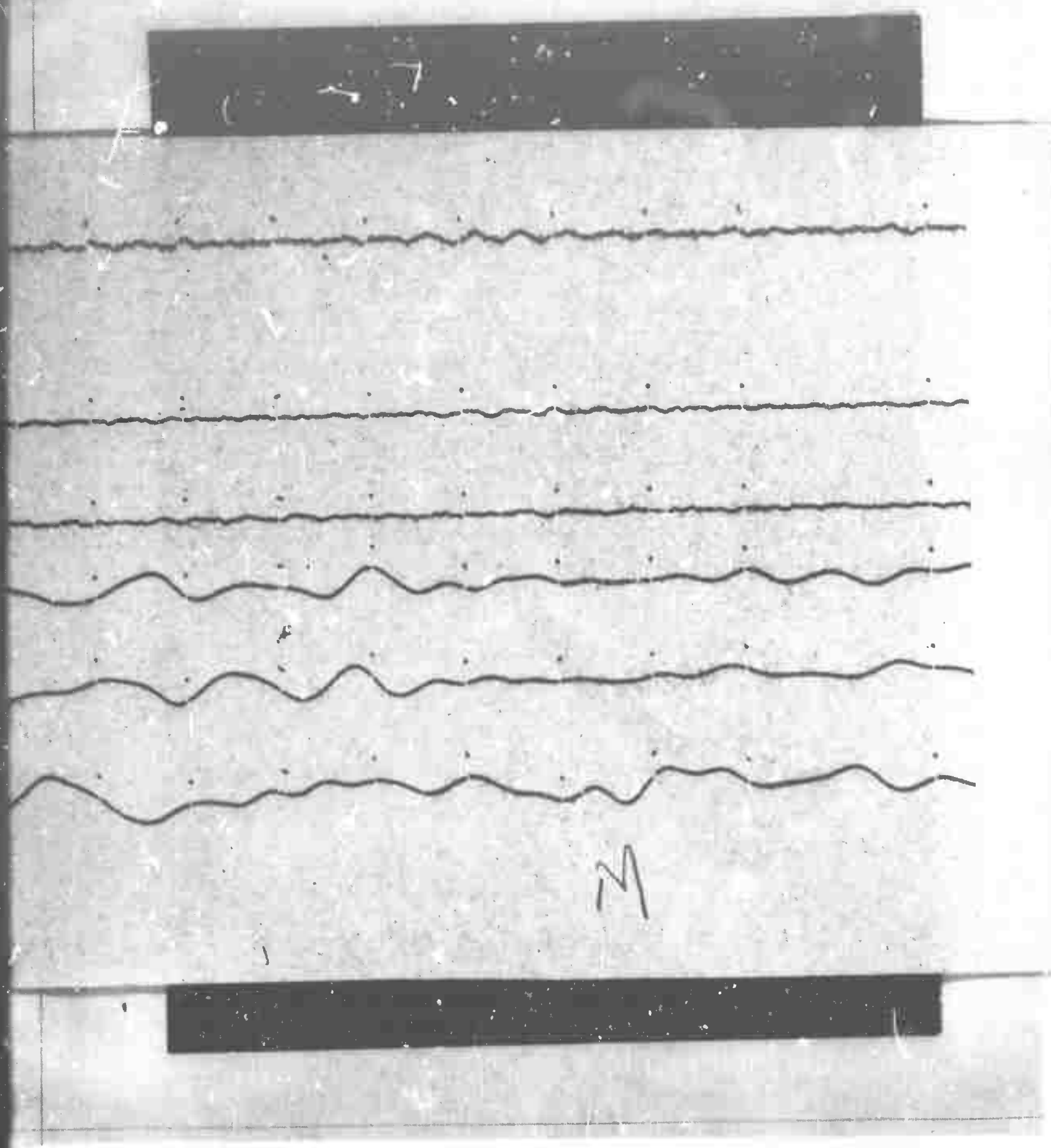


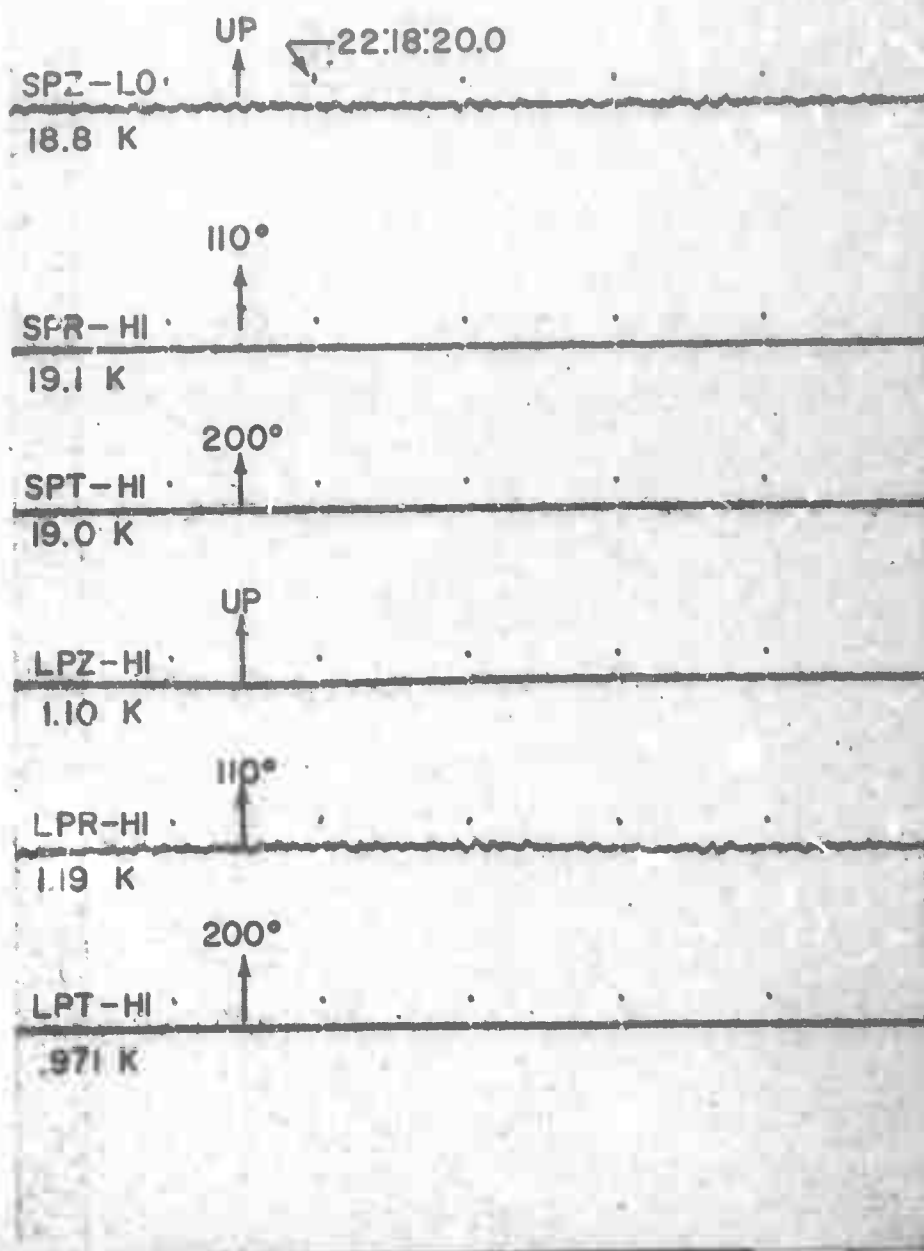
I


1
3


K







HALF BEAK

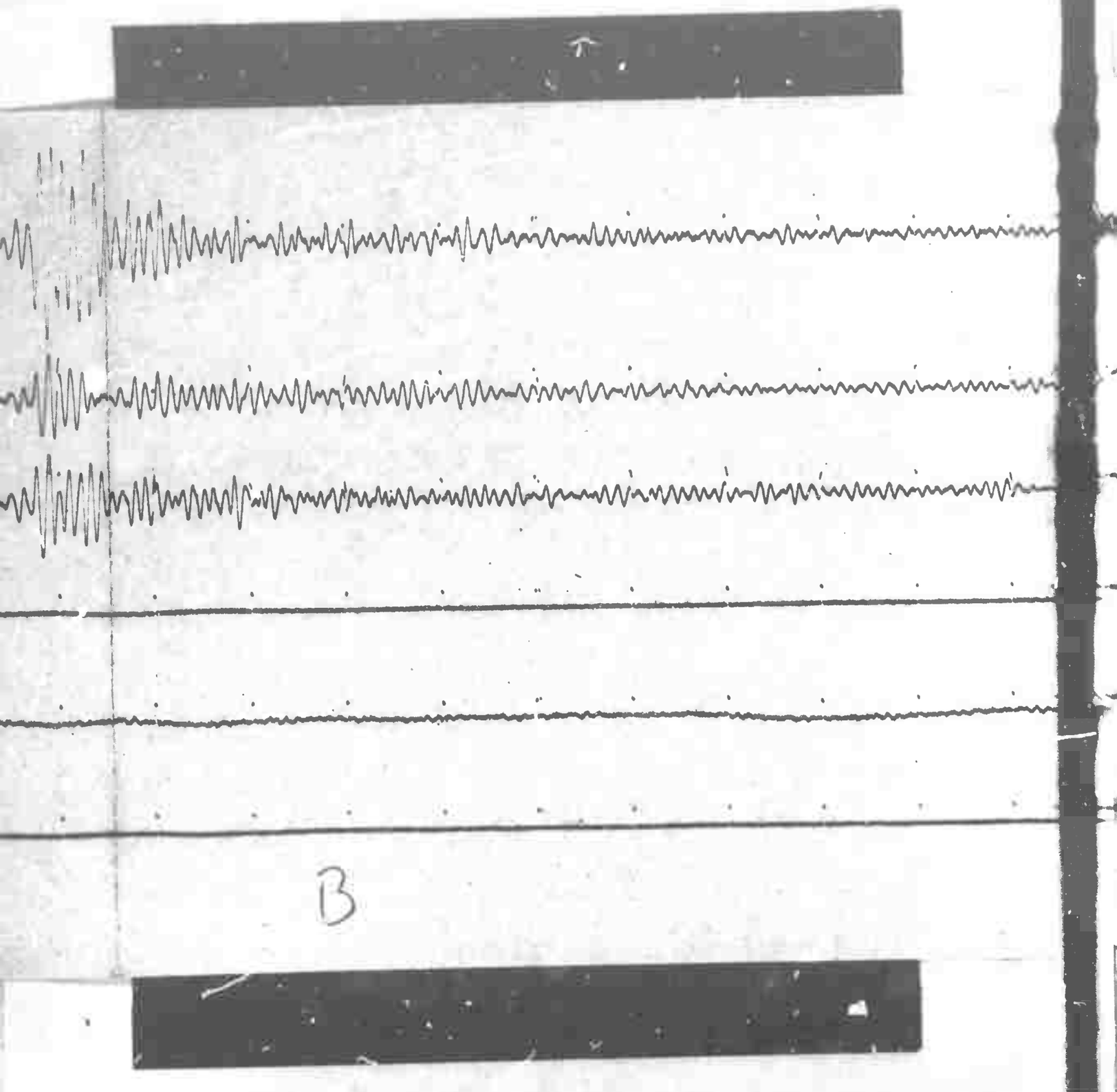
PG--BC

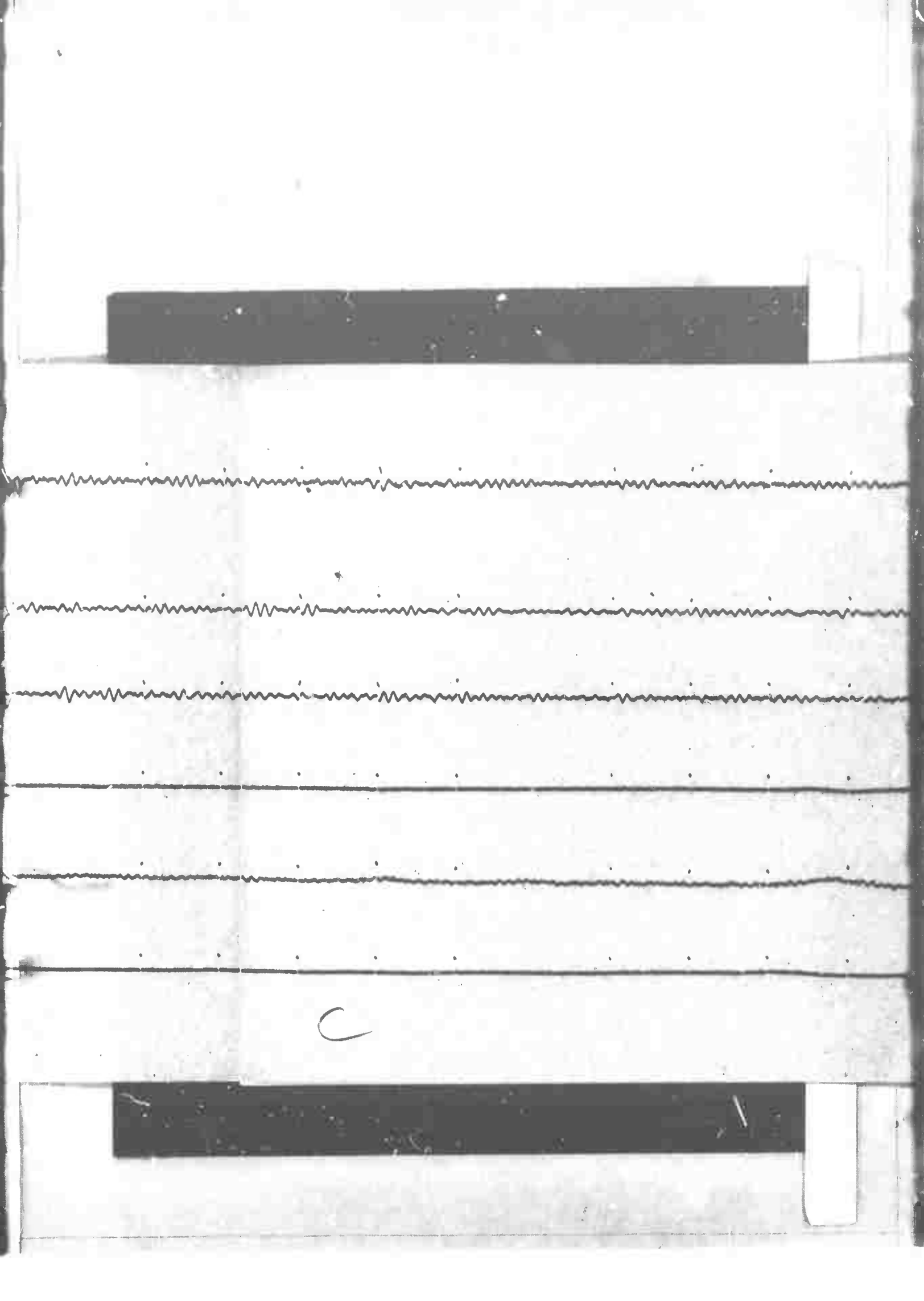
PRINCE GEORGE, BRITISH COLUMBIA

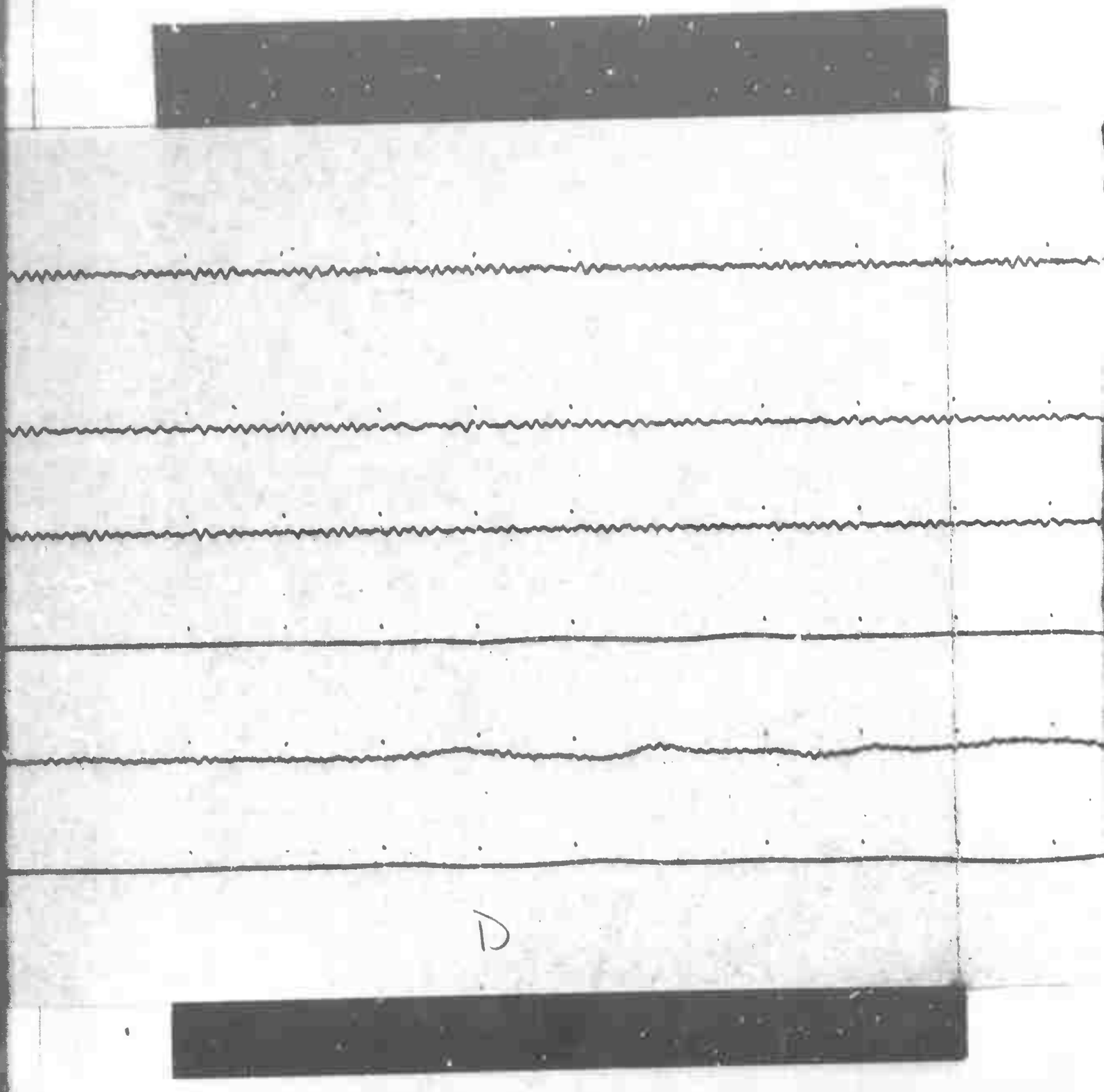
30 JUNE 1966

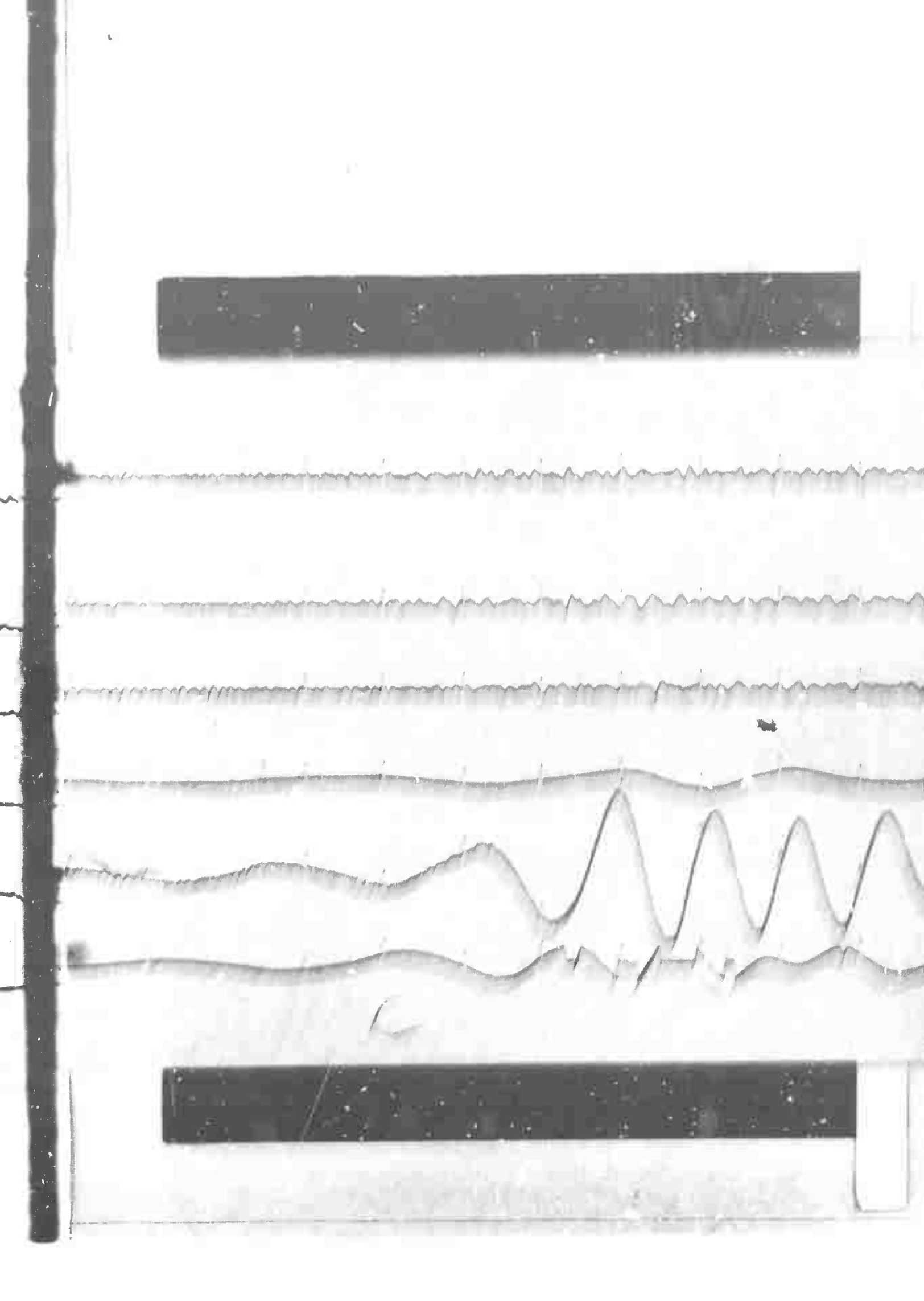
Δ = 1916 km

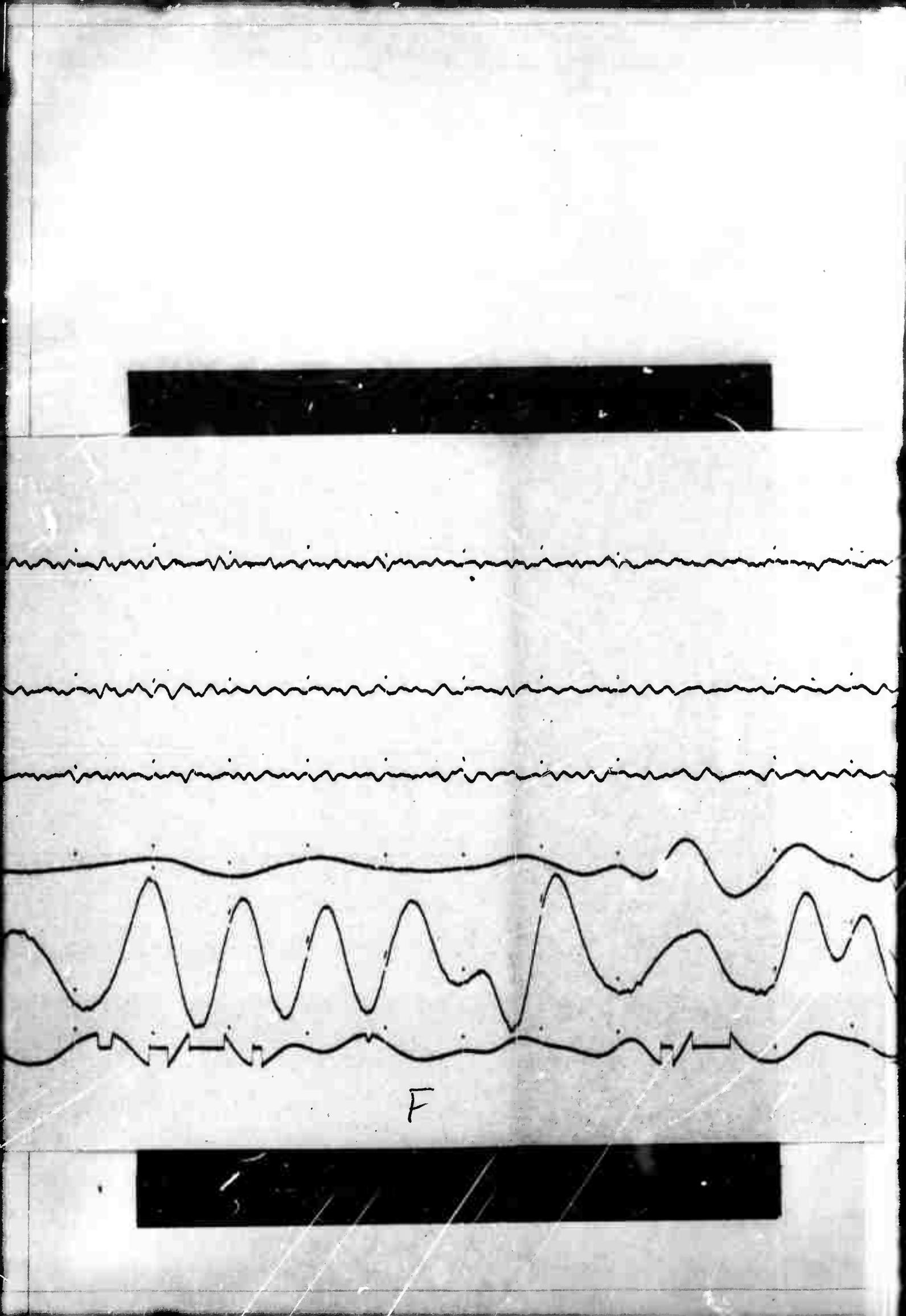
A


B

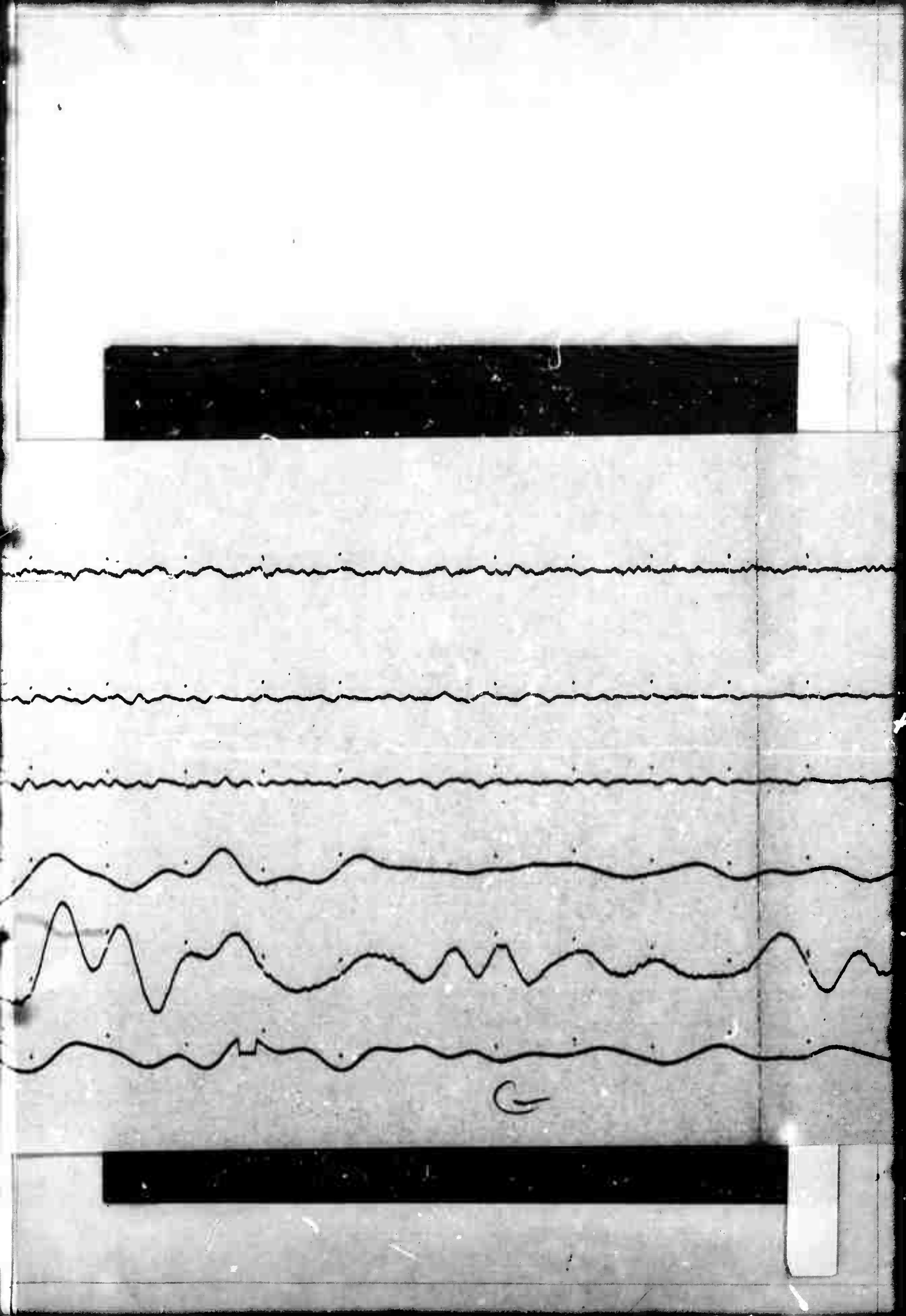




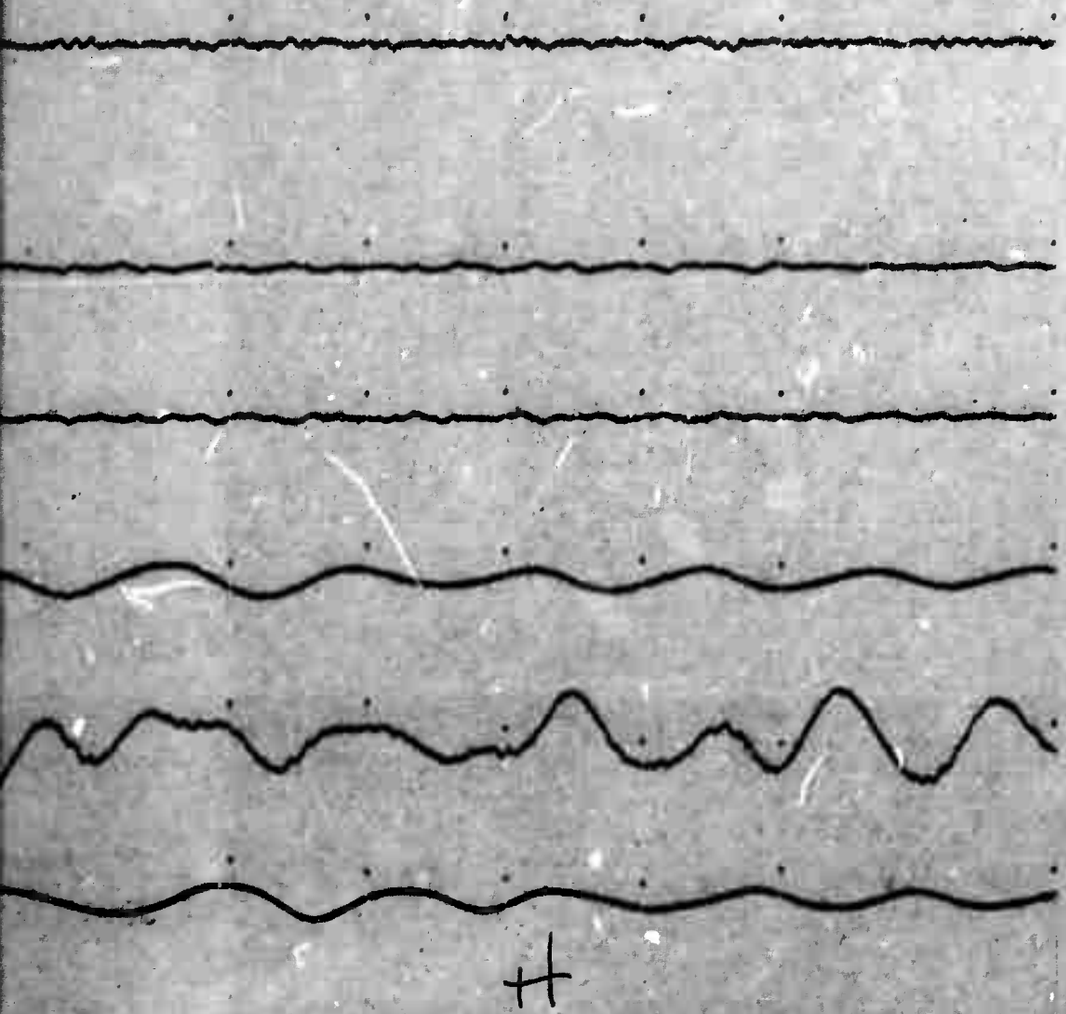




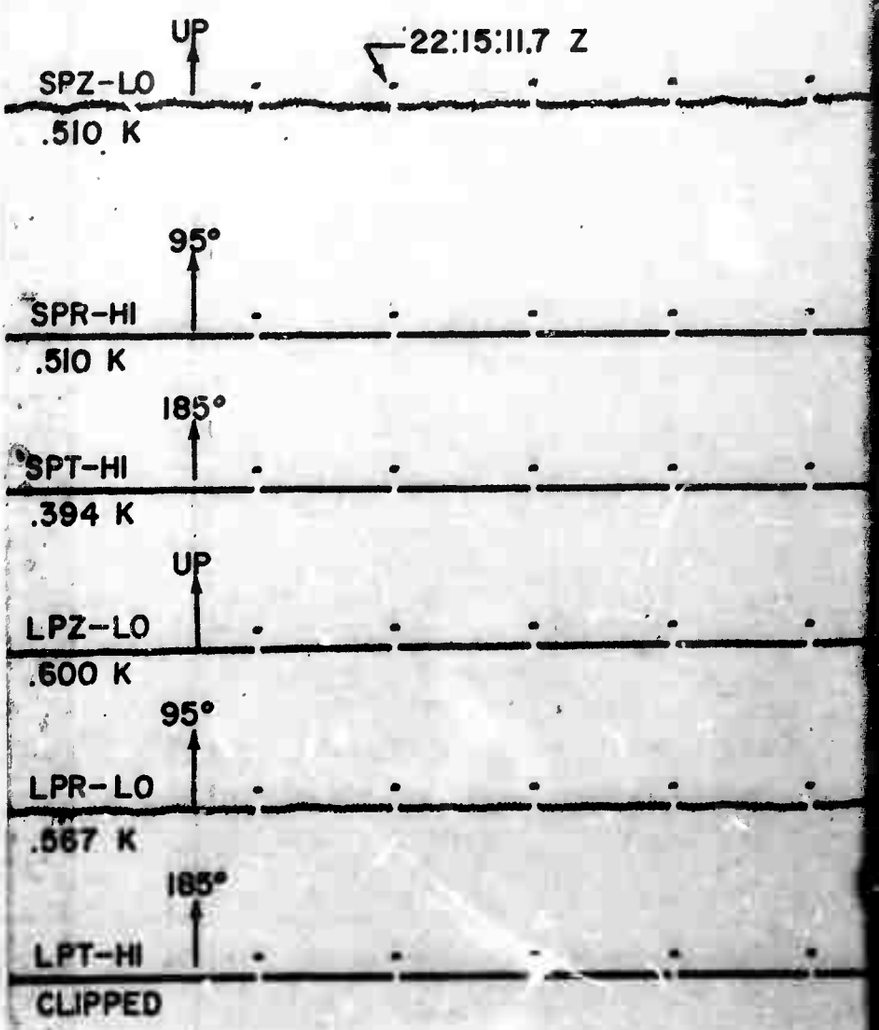
F



[redacted]



[redacted]



HALF BEAK

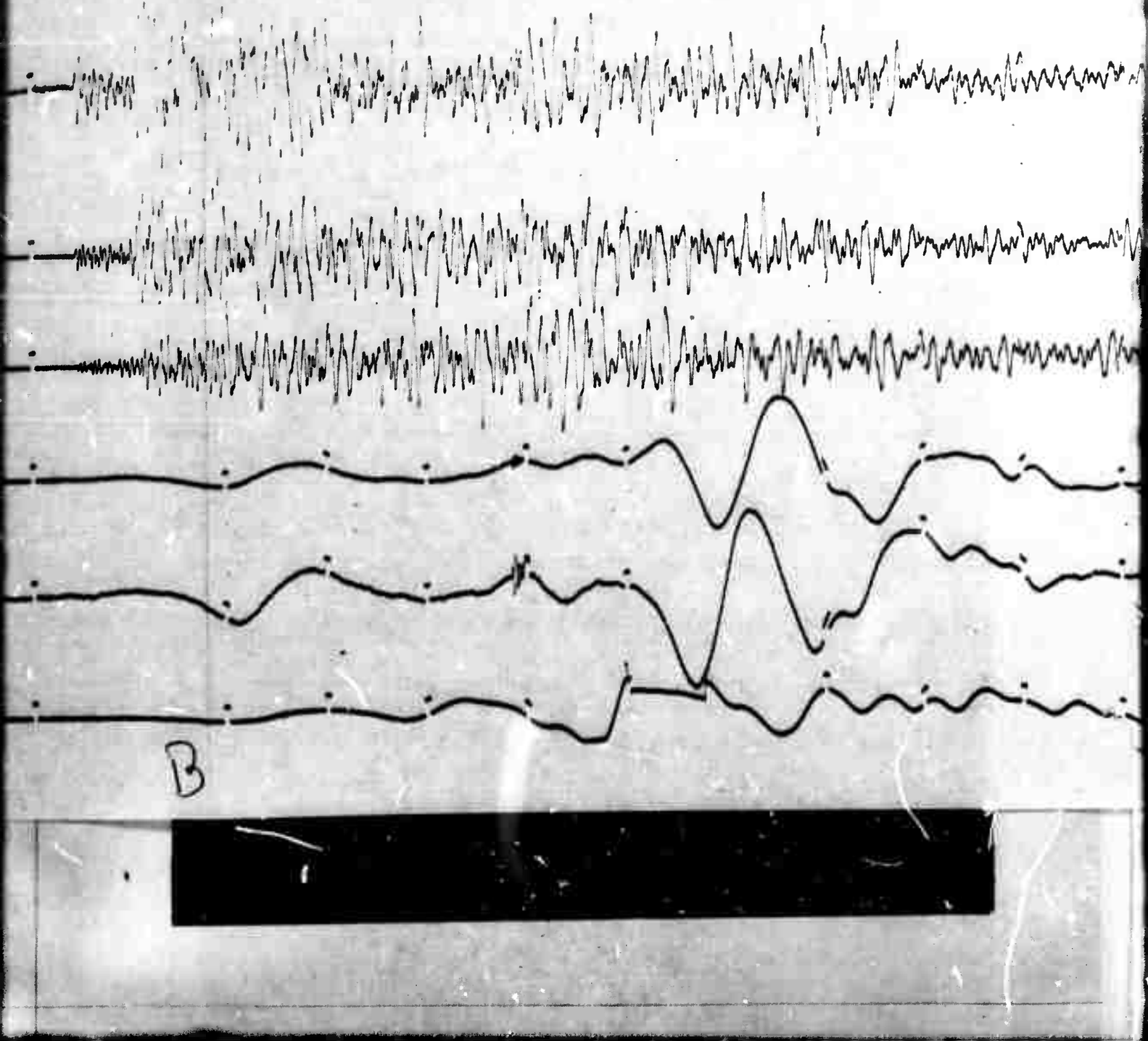
KN-UT

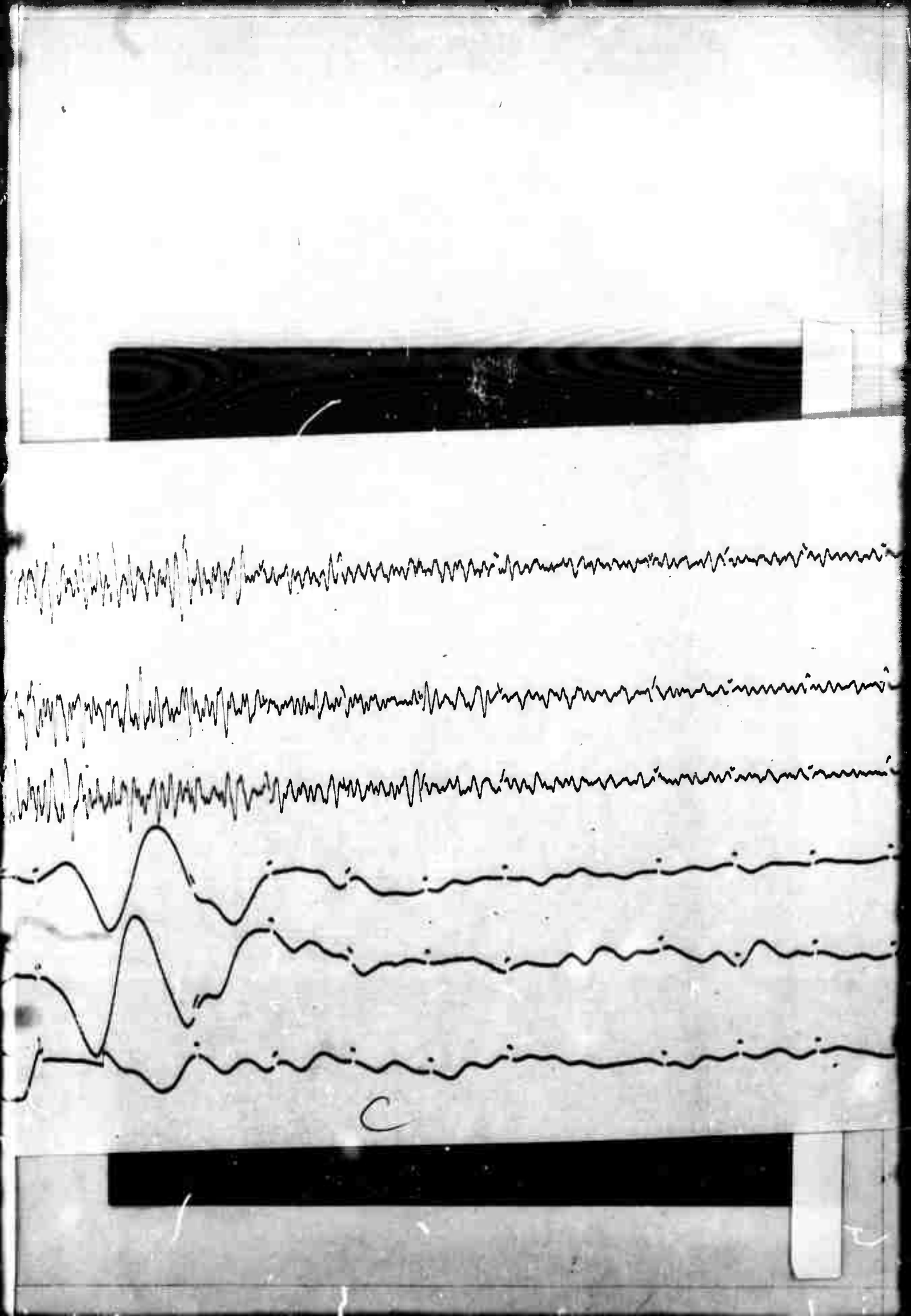
KANAB, UTAH

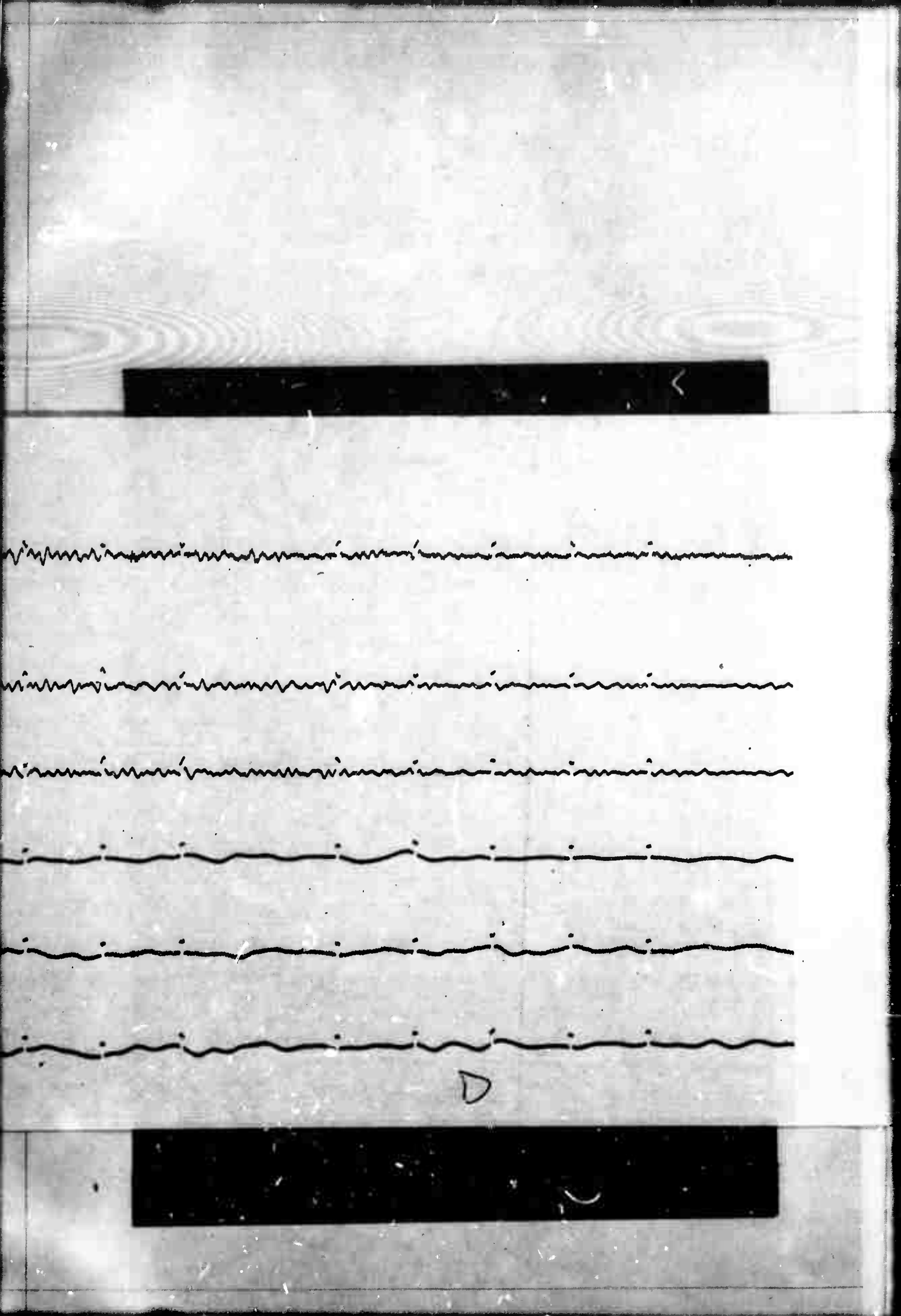
30 JUNE 1966

Δ = 310 km

A


B




C
D

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
TELEDYNE INDUSTRIES, INC.
EARTH SCIENCES DIVISION
ALEXANDRIA, VIRGINIA 22314

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b GROUP
--

3. REPORT TITLE

Long Range Seismic Measurements - HALF BEAK

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Scientific

5. AUTHOR(S) (Last name, first name, initial)

Clark, Don M.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
21 November 1966	20	1

8a. CONTRACT OR GRANT NO. AF 33(657)-15919	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. VELA T/6702	SDL Report No. 171
c. ARPA Order No. 624	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d. ARPA Program Code No. 5810	--

10. AVAILABILITY/LIMITATION NOTICES
This document is subject to special export controls and each transmittal to foreign governments or foreign national may be made only with prior approval of Chief, AFTAC.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
--	ADVANCED RESEARCH PROJECTS AGENCY NUCLEAR TEST DETECTION OFFICE WASHINGTON, D. C.

13. ABSTRACT

An analysis of seismological data from an underground nuclear explosion as a continuing study to provide information to aid in distinguishing between earthquakes and explosions. A table of travel-times and amplitudes of P, Pg, Lg, and surface waves are included along with other unidentified phases.

DD FORM 1 JAN 64 1473

Unclassified

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Seismic Magnitude						
Seismic Travel-Time						
Seismic Amplitude						
VELA-UNIFORM						
Nuclear Tests						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through _____."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through _____."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through _____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS), (S), (C), or (U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

GPO 886-551